

**REVIEW OF THE PROPOSED NATIONAL  
AERONAUTICS AND SPACE ADMINISTRATION  
HUMAN SPACEFLIGHT PLAN**

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**HEARING**

BEFORE THE

**COMMITTEE ON SCIENCE AND  
TECHNOLOGY**

**HOUSE OF REPRESENTATIVES**

ONE HUNDRED ELEVENTH CONGRESS

SECOND SESSION

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MAY 26, 2010  
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# CONTENTS

May 26, 2010

	Page
Hearing Charter .....	2
<b>Opening Statements</b>	
Statement by Representative Bart Gordon, Chairman, Committee on Science and Technology, U.S. House of Representatives .....	27
Written Statement .....	29
Statement by Representative Ralph M. Hall, Minority Ranking Member, Committee on Science and Technology, U.S. House of Representatives .....	39
Written Statement .....	41
Prepared Statement by Representative Gabrielle Giffords, Member, Committee on Science and Technology, U.S. House of Representatives .....	53
Prepared Statement by Representative Jerry F. Costello, Member, Committee on Science and Technology, U.S. House of Representatives .....	54
<b>Panel I:</b>	
Mr. Charles F. Bolden, Jr., Administrator, National Aeronautics and Space Administration	
Oral Statement .....	42
Written Statement .....	45
Biography .....	52
Discussion	
Feasibility of New Budget .....	55
Funding a Crew Rescue Vehicle .....	56
Glenn Research Center .....	58
Maintaining the International Space Station .....	59
The Search for Extra-Terrestrial Life .....	60
Fixing Constellation .....	61
Solid Rocket Industry and Workforce .....	62
Savings From Ares Cancellation .....	62
Cost of a Crew Rescue Vehicle .....	63
Continuing Work on Constellation .....	64
Presidential Visit to the Johnson Space Center .....	66
NASA's Primary Mission .....	67
Space Communications Networks Service Contract .....	68
Space Tourism .....	68
Modifying Constellation .....	69
Termination Liability .....	70
Abdicating Leadership in Space .....	71
Safety Regulations for Commercial Spaceflight .....	71
Promoting STEM Fields Through NASA .....	73
Asteroid Mission .....	74
Timeline for Human Rated Commercial Launch Vehicles .....	75
Constellation Variations .....	76
Potential Commercial Crew Providers .....	76
Infrastructure Costs .....	76
Extending the Shuttle Program .....	77
Maintaining Space Workforce .....	78
Safety Record of Commercial Providers .....	79
Timeline for Commercial Access to LEO .....	79
Ceding U.S. Preeminence .....	81

IV

	Page
Constellation Program Director Reassignment .....	81
Benefits of New Budget .....	82
Termination Liability .....	82
Cost Estimates for Ares Program .....	84

**Panel II:**

Mr. Neil Armstrong, Commander, Apollo 11	
Oral Statement .....	85
Written Statement .....	87
Captain Eugene A. Cernan, USN (Ret.), Commander, Apollo 17	
Oral Statement .....	89
Written Statement .....	92
Mr. A. Thomas Young, Lockheed Martin (Ret.)	
Oral Statement .....	96
Written Statement .....	98
Discussion	
Durability of Private Sector Approach .....	100
Return to the Moon .....	102
Constellation Lite .....	102
Space Shuttle Extension .....	103
NASA Priorities .....	104
NASA Technical Capacity .....	105
Value of Return to Moon .....	108
Workforce Morale .....	109
Viability of the President's Plan .....	111
Impact of the Augustine Report .....	111
Maintaining American Leadership in Space .....	112
Investing in Engine Development .....	113
More on Maintaining American Leadership in Space .....	114
Impact on National Security .....	115
Astronaut Safety Concerns .....	116
Technical Share of the Constellation Program .....	118

**REVIEW OF THE PROPOSED NATIONAL AERO-  
NAUTICS AND SPACE ADMINISTRATION  
HUMAN SPACEFLIGHT PLAN**

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**WEDNESDAY, MAY 26, 2010**

HOUSE OF REPRESENTATIVES,  
COMMITTEE ON SCIENCE AND TECHNOLOGY,  
*Washington, DC.*

The Committee met, pursuant to call, at 10:00 a.m., in Room 2318 of the Rayburn House Office Building, Hon. Bart Gordon [Chairman of the Committee] presiding.

HEARING CHARTER

**COMMITTEE ON SCIENCE AND TECHNOLOGY  
U.S. HOUSE OF REPRESENTATIVES****Review of the Proposed National  
Aeronautics and Space Administration  
Human Spaceflight Plan**MAY 26, 2010  
10 A.M.—12 P.M.  
2318 RAYBURN HOUSE OFFICE BUILDING**I. Purpose**

On May 26, 2010 at 10:00 a.m. the Committee on Science and Technology will hold a hearing on the proposed National Aeronautics and Space Administration (NASA) Human Spaceflight Plan. The purpose of the hearing is to continue the examination of the proposed NASA human spaceflight plan and to review issues related to the budget, cost, schedule and potential impacts of the plan.

The hearing will 1) examine the administration's proposed goals, strategies and plans for NASA's human spaceflight and exploration programs, including the revisions announced by the president on April 15, 2010; 2) the assumptions, basis, feasibility and sustainability of those plans within the FY 2011 budget plan and outyear funding plan; 3) the key challenges and risks involved in implementing the proposed change of course for NASA; and 4) what outstanding questions and issues need to be addressed, and what information is needed as Congress considers the proposed future direction for NASA's human spaceflight and exploration programs.

**II. Scheduled Witnesses****Panel I:**

**Mr. Charles F. Bolden, Jr.**  
Administrator  
National Aeronautics and Space Administration

**Panel II:**

**Mr. Neil A. Armstrong**  
Commander, Apollo 11  
**Captain Eugene A. Cernan,**  
USN (ret.) Commander, Apollo 17  
**Mr. A. Thomas Young**  
Lockheed Martin (ret.)

Dr. John P. Holdren, Director of the Office of Science and Technology Policy, was invited to testify by the Committee but was unavailable due to another commitment.

**III. Background and Issues***Background*

Congress has been presented with the administration's proposal to make drastic changes to the United States human spaceflight and exploration program that has been authorized and funded by successive Congresses since 2005. Key components of the new plan presented by the president in February and later modified in the president's April 15th speech at the Kennedy Space Center include the following:

- The International Space Station (ISS) will be extended at least through 2020;
- An ISS crew rescue vehicle (potentially but not necessarily based on the Orion crew exploration vehicle design) will be developed and flying "within the next few years";
- There will be a human mission to an asteroid by 2025;

- Astronauts will orbit Mars by the mid-2030s;
- By 2015, NASA will have either finalized the design of a Heavy Lift Vehicle (HLV) and be ready to start building [per the president's April 15th speech], have done some design work on an HLV concept [per the OSTP Director's public statements], or have "defined" a Heavy Lift architecture [per NASA statements to staff]; NASA will also have either developed or started development of a new liquid hydrocarbon engine and have carried out fundamental research on heavy lift propulsion, and will have done all of the above for \$3.1 billion over the five-year period;
- NASA will support/fund the development of multiple [3–4, according to NASA] commercial crew transport services by 2016 at a total cost to NASA of \$6 billion; and
- NASA will invest \$7.8 billion in Flagship Technology Demonstrations, \$3 billion in Robotic Precursor mission, and \$4.9 billion on Space Technology over the next few years.

Mr. Norman Augustine, who chaired last year's Review of U.S. Human Spaceflight Plans Committee, has testified that the administration's proposed plan is closest to his panel's Option 5B—one of the "flexible path" options. According to the Augustine committee report, Option 5B *"employs an EELV-heritage commercial heavy-lift launcher and assumes a different (and significantly reduced) role for NASA . . . [and] would also entail substantial reductions in the NASA workforce and closure of facilities to obtain the expected cost reductions."*

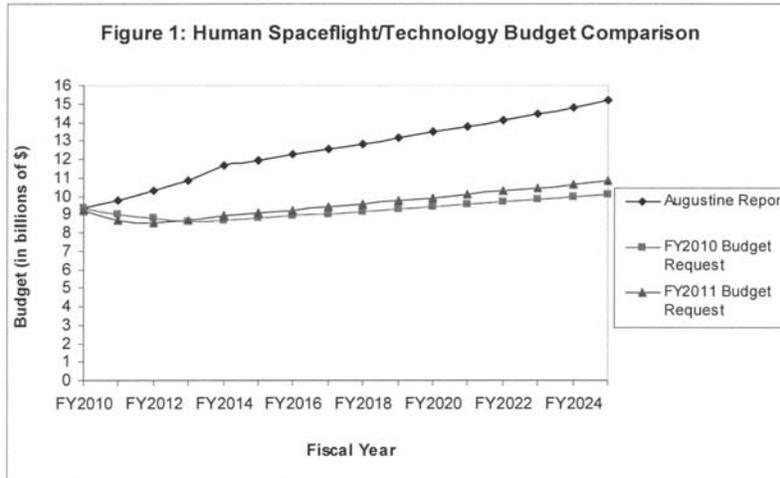
In announcing its proposals, the administration indicated that a new human spaceflight plan was needed because the exploration program of record was *"unexecutable"* under the projected budgets.

In the four months since the administration's proposed plan was announced, a number of significant issues have been raised that still have not been satisfactorily addressed by administration witnesses. A number of those issues are discussed in the following section.

#### *Issues*

1. ***No credible basis has been provided to date to support the claim that NASA can successfully execute the proposed plan within the FY 2011 and assumed outyear budget profile.***

One of the most significant findings of last year's Augustine committee was that *"Human exploration beyond low Earth orbit is not viable under the FY 2010 budget guideline."* Following the same methodology used by the Aerospace Corporation, staff of the Science and Technology Committee analyzed the FY 2011 budget request using the same budget categories used in the Aerospace analysis for the Augustine committee, namely, Shuttle, International Space Station (ISS), Exploration, Kennedy Space Center (KSC) modernization, and exploration-related technology. The staff analysis determined that the funding available for human spaceflight/exploration technology in the proposed FY 2011 budget plan is essentially the same as was available in the "not viable" FY 2010 budget guidance over the years FY 2010–2015. In addition, if one compares the FY 2011 budget plan and outyear funding profile with that of the Augustine committee's "Less Constrained" budget, it turns out the budget for the administration's proposed plan through 2025 [the date of the asteroid mission] is **\$47 billion lower** than the amount the Augustine committee determined would be needed to make any of its exploration options viable over that same period. Figure 1 below illustrates the mismatch between the Augustine committee's budget and both the "not viable" FY 2010 budget guidance and the proposed FY 2011 budget plan. [A spreadsheet comparing the various budgets is included in Appendix A].



The addition of an ISS crew rescue development program without a corresponding increase in the NASA budget would appear to further weaken the credibility of any assertion that the proposed plan is executable. In staff briefings, NASA personnel indicated that a preliminary estimate of the cost of developing a crew rescue vehicle is on the order of \$5–7 billion. Since the administration has stated the goal of flying the crew rescue vehicle “*within the next few years,*” it is reasonable to assume that several years of operations would also have to be budgeted for within the FY 2011–FY 2015 budget. Given the likely need to procure and fly two vehicles per year to the ISS, each on an Evolved Expendable Launch Vehicle (EELV), the annual operating cost could be estimated at \$1+ billion. Thus, the total cost over the five year period of the crew rescue vehicle development/operations program could approach \$10 billion. That is equivalent to a \$1–2 billion per year unfunded lien on the NASA budget. To put that shortfall into context, if one zeroed the FY 2011 funding for the Exploration Technology Demonstrations program, the Robotic Precursor program, and the KSC 21st Century Space Launch Complex initiative, it would only cover \$1.2 billion of the potential shortfall. To cover a \$2 billion shortfall, one would also have to eliminate the increased funding for Earth Science, Aeronautics, and Space Technology. To date, NASA has not identified the planned offsets for the cost of the crew rescue vehicle.

**2. Lack of credible analysis or data and ensuing uncertainties contribute to increased risk of higher costs and longer delays than estimated and increased risk of unavailability of services.**

One of the central elements of the administration’s plan is a proposal to rely on as-yet-to-be-developed “commercial crew” transport services to low Earth orbit and the ISS.

The administration’s plan assumes that it will support the development and demonstration of up to 3–4 commercial crew systems at a cost of \$6 billion over the five-year period FY 2011–2015. [That funding is in addition to funding for launch infrastructure to facilitate commercial launches that is proposed as part of the “21st Century Space Launch Complex” initiative.] However, the basis of the \$6 billion estimate has not been provided to Congress, despite repeated requests. In addition, the administration has been unable to provide the percentage of private sector cost sharing assumed in its \$6 billion budget estimate. There are several grounds for questioning the credibility of the administration’s estimate. The Aerospace Corporation, in its response to questions submitted by Space and Aeronautics Subcommittee Chairwoman Giffords, provided its independent analysis of the range of potential costs to develop a *single* crewed capsule/launch abort system of varying degrees of complexity/crew-carrying capacity. A chart provided by Aerospace that summarizes the analysis is included in Appendix A. For the presently envisioned 2–4 passenger commercial crew vehicles, the Aerospace analysis would suggest that the burden of proof needs to be put on the administration to demonstrate why the cost to the government has not been underestimated by at least a factor of two or more, even ac-

counting for benefits to be accrued by following as yet unspecified “commercial practices” while still ensuring safety standards are met. The \$6 billion estimate is further called into question by NASA’s preliminary estimate of the cost to develop a single “simple” crew rescue vehicle, with the crew rescue vehicle development cost estimate being essentially the same as what the administration estimates could fund the development of up to 3–4 different commercial crew transport vehicles with launch abort systems.

In its report, the Augustine committee concluded that: *“While there are many potential benefits of commercial services that transport crew to low Earth orbit, there are simply too many risks at the present time not to have a viable fallback option for risk mitigation.”* However, the administration’s proposed plan does not include any government backup option. In the absence of a government alternative, NASA would presumably have no choice but to cover any increased cost if it is to preserve its access to the low Earth orbit. Administrator Bolden, in testimony before Congress said *“I have to look at the possibility that the commercial sector may have difficulty, and we will do everything in my power to facilitate their success.”*

In the absence of a significant non-NASA, truly commercial market, NASA would have to assume responsibility for ensuring the continued viability of at least two commercial companies [unless the government is willing to accept the existence of a commercial monopoly determining its crewed access to space]. However the existence of any significant non-NASA market has not been independently validated. Given that, it is instructive to note that at a recent Federal Aviation Administration Commercial Space Transportation Advisory Committee meeting, Administrator Bolden noted that destinations other than the ISS would be needed for the commercial providers in order to keep ISS commercial crew costs down, and that NASA might have to invest in creating them: *“‘We need a destination in low Earth orbit to which we can go’, Bolden said ‘So that means that NASA and the commercial enterprises need to partner, maybe with DoD, maybe with the intelligence community. I don’t know who. But we need to partner with a lot of people to develop a second orbital network of structures or something that act as a destination for people who want to make this commercial industry viable.’”* [Aerospace Daily, 5/20/10]. *In addition, in an aviationweek.com article dated May 21, 2010, it was stated that “company reps agreed that even with a second destination . . . it will be hard to sustain a commercial market with the two annual ISS flights envisioned. ‘A market like that is probably not enough to sustain competition,’ says George Sowers, vice president for business development at ULA [United Launch Alliance]. It could sustain two providers, if NASA’s willing to pay extra to have two. It’s kind of like EELV all over again.’”*

Thus, if one accepts the administration’s assumption that commercial crew providers can be ready to provide operational crew transfer services to the ISS in 2016—a schedule estimate that has not been independently validated and was made without even first having determined what acquisition approach will be followed—all the would-be commercial providers can assume in terms of a NASA market is that they may split a total of 10 trips to the ISS before the end of the planned extension of the ISS in 2020. It is reasonable to assume that in the absence of other markets, those providers will expect NASA to assume the great majority of the risk and cost—whatever that cost might turn out to be.

### **3. Lack of detail and continued changes call into question the stability and sustainability of the proposed plan**

A series of changes to the proposed plan raises questions about the stability of the plan and whether further changes will be forthcoming. The budget justification was provided to Congress one month after the FY 2011 budget release; few details were provided to support the magnitude of the changes being proposed.

On April 15, 2010, the president announced changes to the plan—a major one being the addition of a crew rescue vehicle to the human spaceflight portfolio—and one that represents a significant new requirement being levied on the FY 2011 NASA budget guideline. There were no details on what the change would entail, how it would be funded, and what the impact to other programs would be. In that same speech, the president announced that he was committed to “finalizing a [heavy lift] rocket design no later than 2015 and then begin to build it.” Yet, in subsequent discussions with NASA, Committee staff were told that primary emphasis was on the development of an engine for the first stage of a heavy launch vehicle and just the “definition of a heavy lift architecture” by 2015. Finally, the president added an explicit goal of carrying out the first human mission to a near-Earth asteroid by 2025.

With respect to the crew rescue vehicle program, Administrator Bolden said in his prepared statement for the April 22, 2010 hearing by Senate Appropriations Subcommittee on Commerce, Justice, Science, and Related Agencies: *“Accommodating*

*this effort within NASA's budget will change the amounts requested for the programs described below [technology development and demonstrations; heavy-lift and propulsion research and development; robotic exploration precursor]. An update to the NASA FY 2011 budget justification will be provided as soon as possible, but in the next few weeks.*"

On May 12, 2010, Administrator Bolden testified at a Senate Commerce, Science, and Transportation hearing that "NASA expects to submit a revised FY 2011 budget request to Congress in the near future that will identify funding requirements for the restructured Orion crew capsule".

Given the number and significance of the changes being made to the initial proposed plan, the lack of details on the scope of programs and how they might change to support the addition of a crew rescue vehicle, the variations in the administration's description of how heavy lift development will proceed, and the lack of an updated budget request that reflects the changes, it may be difficult for Congress to have confidence in the stability of the plan that it is being asked to support.

#### **4. Proposed long-term exploration strategy lacks clarity and consistency**

The Constellation Program was designed and congressionally-authorized with a stepping-stone approach in mind "to ensure that activities in its lunar exploration program shall be designed and implemented in a manner that gives strong consideration to how those activities might also help meet the requirements of future activities beyond the Moon" and a range of future destinations "to expand human and robotic presence into the solar system, including the exploration and utilization of the Moon, near Earth asteroids, Lagrangian points, and eventually Mars and its moons." [P.L. 110-422]

However, in presenting his proposed new plan on April 15th, the president stated that with respect to the Moon, "the simple fact is, we have been there before. There is a lot more of space to explore . . ." He announced that the U.S. would send humans to an asteroid by 2025, followed by a human mission to orbit Mars by the mid 2030s.

Subsequent to that announcement, NASA continues to include the Moon as a destination but with no timetable, indicating a lunar landing would not occur until some time after the asteroid mission. Administrator Bolden's May 12 prepared statement for the Senate Commerce Committee noted that "under the new plan, we will . . . build a technological foundation for sustainable, beyond-LEO exploration, with more capable expeditions in lunar space, and human missions to near-Earth asteroids, the Moon, Lagrangian points, and, ultimately, Mars." In addition, Administrator Bolden's prepared statement for the May 12 Senate hearing noted that the Exploration Robotic Precursors program would involve "a lunar lander by 2015" and the Enabling Technology Development and Demonstration program would involve activities "that will lead to ground and flight demonstrations in lunar volatiles." It is not clear whether the Moon is or is not a significant part of the exploration strategy, and if so, what the purpose of lunar exploration would be under the president's plan. If the Moon is not a near-term part of the exploration strategy, it is not apparent why programs to send landers to the Moon and demonstrations in lunar volatiles would be needed within the next five years.

Without a consistent outline of the logical progression for deep space exploration beyond low-Earth orbit authorized in law, how the knowledge from each mission would build on one another, and when a heavy-lift vehicle and crew capsule would be available to support deep space exploration, it is difficult for Congress to have a clear understanding of the plan it is being asked to support.

#### *Implications for Congressional Consideration of the FY 2011 NASA Budget Request*

Given the drastic changes being proposed by the administration, including cancellation of the current Constellation Program, the burden of proof has to rest with the administration to first demonstrate that its proposed plan is executable. That burden of proof includes providing compelling evidence that:

- 1) The proposed plan is executable within projected budgets;
- 2) The elements of the plan are sufficiently well defined and analyzed such that the risks of higher than estimated costs and schedule delays are minimized;
- 3) The plan is well thought-out and stable and has taken account of potential impacts on other sectors; and
- 4) The proposed long-term exploration strategy is clear and consistent.

If that burden of proof is met, Congress will still need to determine whether or not the measures proposed are in the best interest of the Nation and of the nation's human spaceflight program. However, if the administration is unable to provide

Congress with the confidence that its proposed plan is executable, Congress will then need to take steps to develop an alternative that is executable.

Appendix A of this hearing charter contains additional background on the questions and decisions for Congress that are raised by the administration's proposed plan.

## Appendix A

### Background: The Questions and Decisions for Congress on Human Spaceflight and the Proposed New Strategy

#### 1. What Are the Priorities of the Goals and Objectives of the New Strategy That Congress is Being Asked to Support?

Various statements in the FY 2011 budget request and speeches by NASA and other officials state a range of goals and objectives making it difficult to discern the priorities of the goals being proposed for the U.S. human spaceflight program.

- The NASA Administrator’s message in the NASA FY 2011 budget request stated *“As we invest in the most cutting-edge research and technology to enable human exploration beyond Earth, we will also work to cultivate an expanded space exploration industry through a commercial crew program that seeks to spur competition and innovation in American industry, ultimately resulting in commercial human spaceflight services. Once established, these services will not only allow astronauts to travel to the International Space Station, they will ultimately open space travel to many more people across the globe.”*
- In his April 15, 2010 remarks at Kennedy Space Center, the president stated: *“Our goal is the capacity for people to work and learn, operate and live safely beyond the Earth for extended periods of time, ultimately in ways that are more sustainable and even indefinite.”* He also said: *“Early in the next decade, a set of crewed flights will test and prove the systems required for exploration beyond low-Earth orbit. And by 2025, we expect new spacecraft designed for long journeys to allow us to begin the first-ever crewed missions beyond the moon into deep space. We’ll start by sending astronauts to an asteroid for the first time in history.”*

While various goals are being presented as part of the administration’s proposed human spaceflight program, the realities of fiscal constraints within the U.S. government budget require that Congress understands the priorities for those goals. If the administration’s goal is to send humans beyond low-Earth orbit, including to a near-Earth asteroid, as a starting point, by 2025, then a set of decisions must be made to support that goal. If the goal is to stimulate a space tourism and exploration industry, then certain questions must be asked and decisions must be made about the government’s role in enabling the development of a new industry, and the advantages and disadvantages to the government and the taxpayer must be considered.

#### 2. Should the Constellation Program be Canceled?

The Constellation Program consists of the Ares I crew launch vehicle and Orion crew exploration vehicle, the Ares V heavy-lift launch vehicle, associated ground systems and lunar systems. Constellation is the architecture established to deliver Americans to the ISS and later to the Moon and other destinations in the solar system following the retirement of the Space Shuttle. The FY 2009 budget request for NASA stated that Constellation’s Orion vehicle was also intended to serve as a back-up for commercial services being fostered to service the ISS: *“It [Orion] will be capable offerrying up to six astronauts (plus additional cargo) to and from the International Space Station if commercial transport services are unavailable.”* Constellation was authorized in both the NASA Authorization Act of 2005 [P.L. 109–155] and the NASA Authorization Act of 2008 [P.L. 110–422].

NASA provided the Committee the following status information for the Constellation Program, as of May 2010:

*“The following are some of the Orion Project’s key achievements:*

- *The Orion PDR [Preliminary Design Review] was conducted during the summer of 2009, and completed in August 2009. The PDR was an extensive review of Orion’s detailed subsystems and integrated systems designs to date. The PDR board unanimously recommended proceeding with detailed designs toward Critical Design Review (CDR) in February 2011.*
- *In 2009, NASA conducted preliminary capsule recovery tests at both the Navy’s Carderock facility in Maryland and in the ocean near Kennedy Space Center (KSC) in Florida. Using a mockup of the Orion capsule, these Post-landing Orion Recover Tests involved search and rescue teams simulating sta-*

bilization and recovery of the Orion capsule in a variety of sea state conditions. Results were intended to lead to design features for both the spacecraft and recovery equipment, as well as contributing to development of the final recovery procedures.

- Fabrication of the Orion Ground Test Article crew module is progressing at the Michoud Assembly Facility in Louisiana. Completion is estimated for the fall of 2010, followed by completion of the service module and launch abort system ground test article, currently scheduled for 2011. NASA is using a friction stir welding technique on this ground test article, and is hoping to demonstrate the longest continuous friction stir weld ever attempted.
- NASA performed its first developmental flight test of the Orion Launch Abort System (LAS) at the White Sands Missile Range, New Mexico. The Pad Abort-1 test, successfully conducted May 6, 2010, was the first integrated firing of all three motors in a real flight environment. Orion's Launch Abort System (LAS) includes three newly designed solid rocket motors: 1) abort motor, 2) jet-tison motor, and 3) attitude control motor. Each motor contributes substantially to the state of the art in solid rocket propulsion technology. All of these motors have been successfully demonstrated in full-scale static firings on the ground individually.
- Orion project successfully conducted a Software PDR.
- The Orion project successfully completed a formal Integrated Baseline Review to assess the adequacy of the integrated project baseline (cost, schedule, risk, and technical) following the system PDR.

The following are some of the Ares I Project's key achievements.

- Having completed its PDR in 2008, the Ares I Project is now working toward its CDR, which is scheduled for September 2011.
- In September 2009, NASA and ATK conducted the first successful test of the Ares I's five-segment development motor in Promontory, Utah. Beyond validating the basic performance characteristics of the stage, the test has enhanced modeling and understanding of key attributes that have historically been very difficult to predict analytically such as erosive burning, thrust oscillations and thrust tail off. The next static test, DM-2, is currently scheduled for September 2010.
- In October 2009, the Ares I-X test flight took place at Kennedy Space Center in Florida. Data from more than 700 on-board sensors showed that the vehicle was effectively controlled and stable in flight. Thrust oscillation frequencies and magnitude data from the Ares I-X flight also were consistent with measurements from recent Shuttle flights that were instrumented, leading us to conclude that the oscillation vibration on the Ares I would be within the bounds that the Ares I is currently being designed to. In the end, this test flight provided tremendous insight into the aerodynamic, acoustic, structural, vibration and thermal forces that Ares I would be expected to experience.
- J-2X Test Hardware Status: Having passed its CDR in 2008, development and verification testing at the component and subsystem level continues. Current planning includes a fully assembled engine, minus the full nozzle extension, to be available the end of calendar year 2010, followed by receipt of an additional developmental engine in 2011. Static fire testing for engines is currently slated to begin in the February-March 2011 time frame.

The following are some of the recent infrastructure achievements for the Constellation Program:

- The Operations and Checkout building at KSC was completed in January 2009, marking activation of High Bay Facility. When outfitted, the O&C will support final assembly of the Orion spacecraft.
- The final 600-foot Lightning Protection Tower at KSC's Pad B was completed in February 2009. This was where the Ares I-X test flight launched from in October 2009.
- Workers at KSC topped out the tenth and final segment of the new mobile launcher (ML) after it was lifted by crane and lowered onto the ninth segment in January 2010. When completed, the tower will be 345 feet tall and have multiple platforms for personnel access. Its base was made lighter than Space Shuttle mobile launcher platforms so the crawler-transporter can pick up the heavier load of the tower and a taller rocket.

- *A-3 Test Stand at Stennis Space Center in Mississippi. Construction of the long duration altitude test stand for the J-2X engine is nearly 75 percent complete. When completed in 2013, the A-3 facility will provide a unique critical capability to simulate environments at greater than 100,000 ft altitude necessary to demonstrate altitude starting and perform full-duration hot-fire testing.*
- *Space Environmental Test Facility (SET) at Glenn Research Center's Plum Brook Station in Ohio: Construction started in 2007 and is about 75 percent complete. SET is planned for conducting qualification testing of the fully integrated Orion spacecraft, including vibration, acoustics, and EMI testing.*
- *Fabrication of the Orion Crew Module mockup for Neutral Buoyancy Laboratory testing and training events. These events are targeted at both the in-space EVA aspects on the outside of the vehicle as well as for internal cabin mobility within a simulated space gravity environment.*
- *Fabrication of a partial gravity testing and training facility (Advanced Reduced Gravity Off-Load System). This facility allows for simulations of a non-Earth surface gravity environment (lunar, Mars, etc) for both shirt-sleeve and spacesuit testing and training.*

As of May 2010, NASA reported that it had spent a total of \$10.3 billion on Constellation.

In addition, the Constellation Program has contributed a number of new technology developments and innovations. A partial list was provided by Mr. Douglas Cook, NASA Associate Administrator for the Exploration Systems Mission Directorate, at a March 24, 2010 hearing of the Space and Aeronautics Subcommittee on "Proposed Changes to NASA's Exploration Programs: What's Known, What's Not, and What are the Issues for Congress?":

- *"Automated rendezvous and docking is one that we are working on the Orion. In the upper stage we are making further progress on the technology of friction stir welding. We are working on composite structures. We have made some advances in lightning protection on space vehicles, advanced batteries. We are using solar arrays on the spacecraft. We are making advances in guidance, navigation, and control and other avionics software that will be possible. We have actually . . . advanced development work out at Ames . . . in . . . advanced thermal protection systems for spacecraft. We are working on closed life support, and we . . . are actually charting some new territory in modeling of the environments and characteristics of the spacecraft during launch and entry through new modeling techniques and software."*

The FY 2011 budget proposes to cancel Constellation and includes \$1.9 billion in FY 2011 and \$600 million in FY 2012 to fund:

- Termination and liability for existing contracts (including severance pay);
- Closeout costs of content and property disposition;
- Costs to render safe facilities no longer in use, mothballed, or targeted for demolition;
- Potential environmental remediation of agency direct and support contractor facilities no longer in use; and
- Coverage for transitional civil servants as new programs are being initiated.

The April 15, 2010 speech by the president proposed restructuring the Orion crew capsule that was an element of the Constellation Program to focus on providing crew escape capability for the International Space Station by means of an "Orion Lite". A Fact Sheet issued by the Office of Science and Technology Policy described the rationale for the scaled-down Orion as "*providing stand-by emergency escape capabilities for astronauts on the Space Station. We will be able to launch this vehicle within the next few years, creating an American crew escape capability that will increase the safety of our crews on the Space Station, reduce our dependence on foreign providers, and simplify requirements for other commercial crew providers.*" According to the revised plan, this effort will also "*help establish a technological foundation for future exploration spacecraft needed for human missions beyond low Earth orbit.*" Last week, NASA officials informed Committee staff that NASA is in discussions with OMB and OSTP on several options for pursuing a crew rescue vehicle. Those options include 1) restructuring Orion to be developed as a crew rescue vehicle, and 2) initiating a competition that would be open to new concepts for a crew rescue vehicle. A decision to pursue the latter option would necessitate canceling the Orion contract and incurring contract termination costs, while also starting a new contract competition and development program.

*Congressional Direction on Limitations on the Use of FY 2010 Appropriations*

In the Statement of Managers accompanying the FY 2010 Consolidated Appropriations Act, *“The conferees note that the Constellation program is the program for which funds have been authorized and appropriated over the last four years, and upon which the pending budget request is based. Accordingly, it is premature for the conferees to advocate or initiate significant changes to the current program absent a bona fide proposal from the Administration and subsequent assessment, consideration and enactment by Congress.”* The Statement of Managers also states that *“Funds are not provided herein to initiate any new program, project or activity, not otherwise contemplated within the budget request and approved by Congress, consistent with section 505 of this Act, unless otherwise approved by the Congress in a subsequent appropriations Act. Funds are also not provided herein to cancel, terminate or significantly modify contracts related to the spacecraft architecture of the current program, unless such changes or modifications have been considered in subsequent appropriations Acts.”* Similar language was included in the Act itself. According to NASA, the Constellation Program is currently proceeding per the enacted FY 2010 appropriation.

According to NASA, all work that is currently under contract for Constellation will continue. The Administrator has instructed the Constellation Program to refrain from initiating new work not currently under contract, and also to refrain from expanding the scope of any work that currently is under contract. As of March 11, 2010, NASA had canceled five planned procurements, including planned studies: the Exploration Ground Launch Services (EGLS) solicitation at the Kennedy Space Center (KSC); the Vehicle Assembly Building High Bay modification solicitation at KSC; the Water Basin construction solicitation at the Langley Research Center; the Altair Conceptual Design Contracts solicitation at the Johnson Space Center; and the Ares V heavy-lift design trades solicitation at the Marshall Space Flight Center.

In testimony to the Committee on Science and Technology on February 25, 2010, Administrator Bolden stated that: *“in . . . a letter that I sent recently to 27 members of the House who questioned what we were doing with the Constellation Program . . . I told them . . . we were in compliance with the direction of the 2010 Appropriations Act and that I have directed no cancellations or terminations and that we intended to comply with the law.”*

Members of Congress have continued to express concern over NASA’s actions regarding the legislative direction in the FY 2010 Appropriations for NASA. In a May 10, 2010 letter to the Director of the Office of Management and Budget, Senator Barbara Mikulski, chair of the Senate Commerce, Justice, Science and Related Agencies Appropriations Subcommittee that funds NASA wrote:

- *“I am advised that NASA has undertaken a series of steps to direct industry to retain certain funds made available in fiscal year 2010 to cover prospective termination costs so as not to potentially violate the terms of the Antideficiency Act (31 U.S.C. 1341). I am deeply troubled by this approach as it effectively seeks to terminate Constellation activities in apparent violation of the terms of the Omnibus provision.”*
- In addition, Senator Mikulski wrote: *“I urge you, in conjunction with the Vice President and the President’s Chief of Staff to immediately devise a path forward to avoid cancelling contracts in fiscal year 2010 and to avoid invoking termination liability set asides from existing contract dollars and activities on the Constellation Program.”*
- *“I further urgently request that you review NASA’s budgeting practices regarding termination liability to articulate a clear and appropriate standard to deal fairly with industry, provide a schedule to implement this standard and identify the fiscal reserves required to effectively comply with this standard.”*

Senator Richard Shelby, ranking member of the Commerce, Justice, Science and Related Agencies Appropriations Subcommittee, took the step of co-signing a provision to H.R. 4899, the Supplemental Appropriations Act, 2010:

- *“Provided further, That notwithstanding any other provision of law or regulation, funds made available for Constellation in fiscal year 2010 for ‘National Aeronautics and Space Administration Exploration’ and from previous appropriations for ‘National Aeronautics and Space Administration Exploration’ shall be available to fund continued performance of Constellation contracts, and performance of such Constellation contracts may not be terminated for convenience by the National Aeronautics and Space Administration in fiscal year 2010.”*

At issue is the appearance that NASA's actions on Constellation contracts may not be following directions in law and the implications that those actions have for progress on the Constellation Program—the current program of record that has been authorized by Congress and for which Congress has appropriated FY 2010 funds for implementation.

*Justification and Analytical Basis for Cancellation*

- In a September 15, 2009 hearing on the results of the Review of U.S. Human Space Flight Plans Committee, Chairman Gordon asked of the Review's Chair, Mr. Norman Augustine, *"we do have a program that has been authorized we have spent billions of dollars on . . . . So are you prepared to say that one or all of the other options are substantially better than Constellation and worth having a major turn now?"*
  - Mr. Augustine responded *"I think it would be our view just what you said, that there should be a compelling reason to change an existing program, and we believe that the existing program, given adequate funds, is executable and would carry out its objectives."*
- In the Committee's February 25, 2010 hearing on NASA's Fiscal Year 2011 Budget Request, Chairman Gordon noted: *"the justification from moving from Constellation to a different approach is expense, and so if we-if it is not going to be less expensive, then there has to be a better explanation [of] . . . why this move."*
- Since the FY 2011 budget release, additional details on the justification for the proposal to cancel rather than modify or restructure the Constellation program have not been provided. In addition, the actual cost to terminate the program is still not known.
- To understand the factual analysis that informed the Augustine committee, Subcommittee on Space and Aeronautics Chairwoman, Gabrielle Giffords sent a series of questions to the Aerospace Corporation, which was tasked to support the Augustine committee in its review. Regarding a full assessment of Constellation cost and schedule, Aerospace stated *"Aerospace did not perform a traditional parametric or grass-roots Independent Cost Estimate (ICE) for the Constellation Program or its major elements . . . . Aerospace was tasked to perform a high-level schedule assessment of Constellation."*

*Issues Related to the Proposal to Include a Crew Rescue Vehicle*

In addition, in light of the change on April 15th that now includes a crew rescue vehicle (which could involve restructuring the Orion vehicle), the Congress will need to understand a number of issues including: what that vehicle will be, the acquisition approach that NASA will follow (restructuring the Orion contract or pursuing a new vehicle competition and development program), how NASA plans to address the cost and schedule for the rescue vehicle, the impacts of those costs on other NASA programs, and the plan and timeline for moving forward with a deep space crew exploration capsule.

*Issues Related to Proposal to Include a Crew Rescue Vehicle*

- *What are the details of a crew rescue vehicle, including how many crew it will accommodate and how will the program be modified to meet the proposed timeline of "the next few years"?*
- *What, if any, supporting infrastructure is needed for a crew rescue vehicle and what will it cost?*
- *What are the timeline and plans for deciding on and developing a crew capsule to explore destinations beyond low-Earth orbit and what costs are assumed for that development?*
- *What are the implications of the decision on a crew rescue vehicle on the civil servant and contractor workforce, as well as on the space industrial base?*
- *If the addition of a NASA funded crew rescue vehicle has reduced the capabilities that commercial crew systems will have to provide, will the \$6 billion commercial crew budget be reduced accordingly? If not, why not?*

To date, NASA has not provided this information to Congress.

- In his prepared statement for the April 22, 2010 Senate Appropriations Subcommittee on Commerce, Justice, Science, and Related Agencies, NASA Administrator Bolden said: *"Accommodating this effort within NASA's budget*

*will change the amounts requested for the programs described below [technology development and demonstration; heavy-lift and propulsion research and development; robotic exploration precursor]. An update to the NASA budget justification will be provided as soon as possible, but in the next few weeks.”*

- On May 12, 2010, Administrator Bolden testified at a Senate Commerce, Science, and Transportation hearing that “NASA expects to submit a revised FY 2011 budget request to Congress in the near future that will identify funding requirements for the restructured Orion crew capsule.” In addition, Mr. Bolden stated during the hearing that the Orion variant will launch on an Evolved Expendable Launch Vehicle (EELV), however there are no details on what the EELV would cost, whether design changes would be required, when the vehicle could be available and how it would be funded within the FY 2011 budget plan for NASA.
- Prior to the April 15, 2010 announcement about Orion, Administrator Bolden was quoted in a March 30, 2010 article in Aviation Week and Space Technology as expressing his interest in a “common crew capsule” during a Senate Appropriations Hearing held on March 23, 2010. “For his part, Bolden says he favors development of a ‘common crew module’ that could fly on several different commercial launch vehicles.” According to the article Mr. Bolden also stated: “I would like to help the commercial entities design a single crew module, because it’s good for us to train,” he says. “You don’t have to train crews for multiple crew modules, and that can be used interchangeably on any launch vehicle.” It is not clear whether NASA has discussed this option with potential commercial crew providers, whether they have any interest in such an approach, and whether it is consistent with a “commercial” approach to crew transfer.

### 3. *Is the Proposed ISS Extension Program Funded and Organized to Accommodate the Extension?*

The NASA Authorization Act of 2008 [P.L. 110–422] states that “*The Administrator shall take all necessary steps to ensure that the International Space Station remains a viable and productive facility capable of potential United States utilization through at least 2020.*”

The NASA FY 2011 budget request includes the proposal to extend use of the ISS beyond 2016, likely through 2020 or beyond, in order to utilize the orbiting facility as a basic research facility and a test bed for exploration technology development and demonstrations. NASA is requesting \$2.78 billion in its proposed FY 2011 budget to support these efforts and to initiate activities to increase ISS functionality. Under the revised April 15th plan there are no changes to extension of the ISS, however the revised plan restructures Orion to “*provide stand-by emergency escape capabilities for the Space Station.*” There are several issues on the research and contingency plans to support enhanced utilization and an extension of the ISS that have yet to be defined.

#### *Issues That Need to Be Addressed on ISS Extension*

- The proposed FY 2011 budget plan does not make clear how much of the increase will be used to support enhanced ISS utilization. Although the budget proposes \$50 million a year for ISS research as part of the budget for ISS operations, there are no details on what the budget would support. NASA has indicated to Committee staff that the content of the ISS research budget has not yet been defined.
- In addition, the budget request does not identify the proposed budget for microgravity research as mandated in Section 204 of the NASA Authorization Act of 2005 [P.L. 109–155]: “*Beginning with fiscal year 2006, the Administrator shall allocate at least 15 percent of the funds budgeted for ISS research to ground-based, free flyer, and ISS life and microgravity science research that is not directly related to supporting the human exploration program.*” Congress will need to understand the extent to which the budget request will support congressionally-mandated research and enhanced utilization of the ISS.
- Multiple users and stakeholders are discussed with respect to ISS utilization, including universities and basic researchers, NASA mission programs, commercial and private entities as well as other Federal agencies that are partners in the ISS National Laboratory. In his prepared statement to the Senate Committee on Commerce, Science, and Transportation in a hearing on U.S. Human Spaceflight held on May 12, 2010, Administrator Bolden stated that

“NASA will initiate an independent organization, as recommended by the Augustine Committee and the National Research Council that will support the space station research community.” Congress will need further details to understand how the priorities for utilization resources will be established among these users and stakeholders, the roles and responsibilities of this proposed independent organization and how it will be selected and funded.

- The NASA Authorization Act of 2008 directed NASA to develop a contingency plan for cargo transportation to and from the ISS should the commercial cargo services be delayed, unavailable for extended periods, or experience a failure. NASA’s “Logistics Contingency Plan for the International Space Station” transmitted to the Committee in response to the 2008 Authorization direction does not provide a clear contingency plan. The report stated that: “Cargo vehicles require 2–3 years of lead time for production and processing, and international partner vehicles have a production schedule based on current predicted needs. There is no plan to have additional vehicles in production to cover for delays in commercial cargo services. However, actual cargo manifesting can be adjusted closer to the planned flight dates. Therefore, the primary contingency plan is to closely monitor on-orbit systems and cargo demands and adjust as needed. This may include not having to fly spares as soon as currently predicted, or reducing utilization to meet an emerging need.”

While the proposed FY 2011 budget plan includes an extension of the ISS to 2020, Congress continues to lack several details and plans that are needed to ensure that the infrastructure, plans, and resources would be in place to support the ISS extension and utilization.

#### 4. *Should Congress Support the Proposal to Develop and then Rely on Commercial Cargo and Crew Capability as the Nation’s Access to Low Earth Orbit?*

The proposed plan in the FY 2011 budget does not include a U.S. government capability to launch American astronauts and to deliver cargo to the ISS. NASA plans to rely on commercially provided cargo transportation services for ISS resupply starting in the 2011 timeframe using its Commercial Resupply Services (CRS) contract. NASA is currently funding two partners in the Commercial Orbital Transportation Services (COTS) Program to develop and demonstrate commercial cargo delivery capability to the ISS—Space Exploration Technologies Corporation and Orbital Sciences Corporation.

When the Space Shuttle is retired, NASA anticipates that crew access to the ISS will be provided by acquiring seats on Russian Soyuz spacecraft until the 2016 timeframe.

Under the president’s proposal, the agency plans to cease using Soyuz spacecraft at that time and anticipates using commercially-provided crew transport services instead. Funding in FY 2011 for ISS cargo/crew is about \$857 million; a total of \$5.77 billion is projected for the period of FY 2011 through FY 2015. The FY 2011 budget requests an additional \$312 million—a 62% increase in the cost of the COTS program—to expedite ISS cargo development and to help ensure mission success. According to NASA’s budget justification, “*The Commercial Crew Program will provide \$6 billion over the next five years to support the development of commercial crew transportation providers to whom NASA could competitively award a crew transportation services contract . . .*” The revised April 15th plan makes no changes to the plan to rely on the use of commercial services to deliver cargo and crew to and from the ISS, although in adding a crew rescue vehicle, the revised April 15th plan eliminates the crew rescue requirement for potential commercial crew providers.

#### *Does Congress Have the Analytical Basis to Support a Decision on Commercial Crew?*

In her opening statement for the March 24, 2010 Subcommittee on Space and Aeronautics hearing on NASA’s human spaceflight programs, Chairwoman Giffords summarized the status of a series of issues examined at a series of Committee and subcommittee hearings held:

*“The clock is ticking. It is now almost two months since the Administration’s FY 2011 budget request for NASA was submitted to Congress, and there are still too many unanswered questions surrounding it.”*

*“In place of good explanations and solid rationales for such sweeping and frankly puzzling changes, we have been given a combination of unpersuasive arguments and ‘we’re working on the details’ responses.”*

For instance, the commercial crew proposal is lacking all of the basic information that a would-be investor would demand before committing funds to a project. For example:

- What's the proposed cost to the government to develop these systems?
- How much, if any, of the development cost will be shared by the companies?
- How much will it cost NASA to buy these services?
- What else will NASA have to provide to make—and keep—the companies' operations viable?
- When can we credibly expect these services to be operationally available and will they meet our expectation of what is safe enough?
- What recourse will NASA have if the companies fail to meet safety standards, cost, schedule and performance?
- Finally, is there any significant non-NASA market for these services; is it a viable one; and is it one we should use scarce tax dollars to promote?"

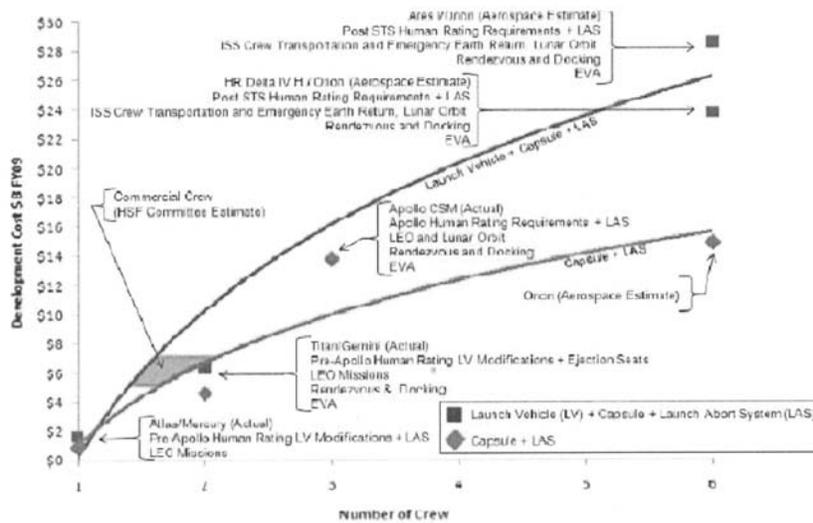
It is now two months after the March hearing, the Committee still lacks critical details and information about the plan.

- It is unclear what the government is buying for the proposed \$6 billion to foster the development of commercial crew capability—a capsule, a launch vehicle, or both? The FY 2011 budget request states that *“Unlike the COTS program, which exclusively funded entirely new and integrated systems (launch vehicles plus capsules), this program will also be open to a broad range of commercial proposals including, but not limited to: human-rating existing launch vehicles, developing spacecraft for delivering crew to the ISS that can be launched on multiple launch vehicles, or developing new high-reliability rocket systems.”*
- NASA has provided no information as to whether the \$6 billion requested is the government's total share needed to complete the proposed commercial crew demonstrations or whether additional government support would be required for developing commercial crew capability. This information is purportedly to be informed by responses to a Request for Information, which was released on May 21, 2010.
  - However, this issue takes on greater significance in light of comments reported in a recent issue of *Space News* by the director of business development for United Launch Alliance (ULA), one of the potential commercial crew transport providers. The April 5, 2010 article says that *“As NASA devises its strategy for fostering development of a commercial successor to the space shuttle, the Nation's primary rocket builder is cautioning the agency not to count on industry for a substantial upfront investment in an endeavor rife with uncertainty.”*
- In response to Chairwoman Giffords' request noted earlier, the Aerospace Corporation stated that it was given the cost to assume in its affordability analyses for developing multiple commercial crew systems; it did not independently develop that cost.
- Details on the basis for the budget estimate of \$6 billion for developing commercial crew capability are still needed.
  - The Augustine committee report estimated the DDT&E cost to NASA would be \$3 billion and would involve two commercial competitors and a government-provided rocket. The Aerospace Corporation's responses to Chairwoman Giffords stated that: *“Aerospace did not independently develop the basis for the \$3B initial estimate. The Committee did not ask Aerospace to independently verify the \$3 billion figure. In fact, no verification could be performed given the Committee's statement that this dollar amount was simply NASA's portion of the total cost.”* The Aerospace responses also noted that *“The Committee's final estimate of the cost of the program to NASA was approximately \$5 billion. It was assumed that additional private investment funding would be required to complete the DDT&E.”*
  - NASA officials told Committee staff that NASA plans to use the \$6 billion to support developing commercial crew capability in 3–4 companies.
  - The Aerospace Corporation's responses to Chairwoman Giffords further indicate the approximate cost estimate proposed by the Augustine committee is consistent with the historical cost of developing a single crew transportation system to carry 1–2 crew (Figure A.1). However,

Aerospace’s analysis suggests that for a crew of 4, development costs for a crew capsule and a launch abort system could be substantially higher. When adding a launch vehicle, the costs could increase even more. Aerospace notes that “*Gemini is the closest historical program to the commercial crew capsule. While we have chosen to plot development cost vs. crew size, the complexity of the system is a function of human-rating requirements, destination and capability.*”

- Indeed, the data plotted in the Aerospace responses give serious grounds for concern that the Augustine committee’s assumed cost estimate may understate the actual costs of developing commercial crew by at least a factor of two or more, especially when the additional cost of providing a “suitable version of an existing booster,” e.g., human-rating an EELV, is added—something that Aerospace has independently estimated could cost up to an additional \$11 billion, depending on the capsule/launch abort system chosen, if ground infrastructure costs are included. It goes without saying that given NASA’s constrained budget, the impact of any such cost growth in the proposed commercial crew program would have to be absorbed by NASA’s other programs.
- Given the lack of independent analysis provided to Congress to justify the \$6 billion estimate and the Aerospace Corporation’s own analysis of potential commercial crew development costs, the credibility of NASA’s proposal remains to be demonstrated.

Figure A.1.



Source: Aerospace Corporation, Responses to Questions from Rep. Gabrielle Giffords, March 23, 2010

- In addition to the development cost, NASA has provided no independently derived estimates of the potential cost of procuring crew transportation services. According to the Aerospace Corporation, “*The Committee provided the commercial crew transportation assumptions that assumed a price of \$200M FY 09 per flight at a rate of 2 flights per year. Using a historical cost growth factor for operational systems, Aerospace increased the cost per flight to \$250M FY09. The Committee did not define the crew capacity of the commercial crew vehicle. Based on the 2 Gemini-class crew module discussed above . . . the cost per seat would be on the order of \$125M FY09 but would vary with crew size.*”
- The timeline for the availability of commercial crew is also in question. The Aerospace Corporation did not independently develop or verify the 2016 esti-

mate for the availability of the commercial crew capability. In fact, Aerospace was told to *assume* a date of 2016 for when a commercial capability would become available. Aerospace said that “*The Committee provided the schedule estimate for the commercial crew scenario as an input assumption, which was then used for the subsequent affordability analyses.*” Aerospace also said that it “*has not performed any analysis or assessment of the length of time it would take to develop, demonstrate, and contract for an operational commercial crew transport service.*”

- Information on when the government will need to contract for crew services to meet an anticipated commercial crew timeframe and the cost of crew services is needed to evaluate the government’s complete plan and cost for getting American astronauts to the ISS on commercial vehicles.
  - Aerospace raised questions related to the acquisition steps the government would need to follow to develop and procure commercial crew transport services—steps which Aerospace stated “*typically take on the order of many months,*” but the Augustine committee did not request any analysis of the impact of those steps on the cost or schedule for commercial crew—and there is no indication that the impact of those steps was considered when the Administration’s plan was formulated. Indeed, Aerospace said in response to one of Chairwoman Giffords’ questions that “*This is a critical question. While we raised these questions in the development of our work for the Committee, we were not tasked to develop this analysis. Subsequent to the release of the Committee Report, we have met with the NASA Administrator and key staff to discuss these issues. To our knowledge, NASA is currently evaluating these steps. Based on Aerospace’s prior experiences on a wide range of government acquisition activities, the acquisition-related steps are numerous, and include such steps as described in the Question 4 above. These steps typically take on the order of many months.*”
- Details on how development of a crew rescue vehicle for the ISS would “*simplify requirements for other commercial crew providers*” need to be understood in terms of, for example, any changes in the potential cost and schedule estimate for developing commercial crew capability. For example, will the simplification involve a consequent reduction in the \$6 billion allocated for developing commercial crew capability?
- Details on which sector—government or commercial—would fund the needed supporting infrastructure, including mission control, have not been provided.
  - In addition, details about programs that would support the commercial crew capability and a commercial space market are also needed. For example, the proposed FY 2011 budget also requests \$428.6 million in FY 2011 and \$1.9 billion over five years for a 21st Century Space Launch Complex, in part to attract new customers, including potential commercial crew companies, to the Florida space range. NASA has not provided the requirements for the proposed complex, a detailed plan for the initiative, or a rationale for the funding requested. In addition, the administration has not provided a break-out of how the money would be spent. The requirements for the proposed Complex will be derived from a Request for Information that NASA plans to issue in the near term, according to NASA officials who briefed Committee staff on the status of planning for the Complex. Although NASA officials indicate that detailed planning for the proposed Complex would involve interaction with the U.S. Air Force, which operates the Cape Canaveral Air Station, the Air Force is currently in the process of analyzing its launch enterprise strategy for which it has requested \$51 million in FY 2011 for launch modernization at Cape Canaveral and Vandenberg—a funding level that is almost an order-of-magnitude *less* than is being proposed just for the Cape in NASA’s FY 2011 budget request. Without details on the requirements for the Space Launch Complex, a detailed plan, a rationale for the level of funds requested and further information on how the money would be spent, it will be difficult for Congress to evaluate the credibility or urgency of the 21st Century Space Launch Complex initiative.

Another policy issue to be addressed in considering the proposal to turn U.S. astronaut transportation over to the private sector is the extent of the government’s role in supporting and sustaining a “commercial” market.

In his opening statement at the Committee's February 25, 2010 hearing on NASA's Fiscal Year Budget Request, Chairman Gordon posed the following questions:

- *“Do you have concrete evidence that you can provide us that shows that there will be sufficient non-NASA commercial crew transport markets to keep these companies viable, or is NASA going to be on the hook to do whatever it takes to keep them in business since NASA will have no other means of getting into orbit?” “That is, will NASA’s actions make these companies “too important to fail” despite the lack of any significant existing markets for their proposed services—with all of the implications for the American taxpayer inherent in that phrase?”*
  - In response, Administrator Bolden stated: that *“unfortunately, it is not—we at NASA have not done any market surveys nor have . . . I offered to do that or asked to do it, so I am depending upon surveys and information that has come from the industry themselves.”*

According to an unofficial transcript of a hearing that reviewed NASA's human spaceflight plans held by the Senate Committee on Commerce, Science, and Transportation on May 12, 2010, NASA Administrator Bolden stated:

- *“I have always said, I will do everything in my power to facilitate the success of the commercial entities in access to low-Earth orbit. I have to have that.”* He also said, *“You know, I have to look at the possibility that the commercial sector may have difficulty, and we will do everything in my power to facilitate their success.”*
- Captain Eugene Cernan testified at that same hearing that Mr. Bolden discussed with him his concern about when commercial crew capability might become available, had said that NASA might have to subsidize them, and that *“it may be a bailout like GM and Chrysler; as a matter of fact, it may be the largest bailout in history,”* according to the unofficial transcript of the hearing.

*Does Congress Have the Facts and Analysis to Have Confidence in the Safety of Proposed Commercial Crew Services?*

The Subcommittee on Space and Aeronautics examined several issues related to safety and human spaceflight in its December 2009 hearing, “Ensuring the Safety of Human Space Flight.” The hearing made clear that establishing and enforcing safety standards for the transport of crew on commercially provided orbital crew transportation services is in many ways uncharted territory. A process has yet to be advanced by the government on how the “airworthiness” of commercial spaceflight vehicles used to transport government passengers will be “certified.” Several issues need to be addressed in order for Congress to have the data and analysis of how safety will be ensured in proposed commercial human spaceflight systems.

In her opening statement at that hearing, Chairwoman Giffords said:

- *“As several of the witnesses at today’s hearing will testify, the Constellation program strove to respond to the recommendations of the Columbia Accident Investigation Board in the design of Ares and Orion.*
- *The result is a system that is calculated to be significantly safer than the Space Shuttle, and 2 to 3 times safer than the alternative approaches considered by NASA.*
- *Given that, I think the burden of proof has to be put on those who would deviate from Constellation program to demonstrate that their alternative crew transportation systems will be at least as safe, if not safer than the Ares/Orion system.”*

Addressing the latter issue that Chairwoman Giffords raised involves several questions and issues:

- *What will be required to verify commercial providers’ compliance with future government-developed safety standards for human spaceflight?*
- *Commercial companies are currently developing launch systems that would potentially be used to carry crew. What are the implications of implementing safety standards after a vehicle has been designed and developed?*
- *What is needed to develop and implement new safety processes, testing and verification procedures?*
- *What is involved in establishing a new regulatory regime for certification?*

- *What training and familiarization with non-NASA crewed spacecraft and launch vehicles would astronauts flying on such non-NASA spacecraft and launch vehicles need in order to deal with off-nominal conditions, contingency operations and emergencies?*
- *What contingencies would be in place should commercial crew providers experience delays, failures, or be unavailable for an extended period of time?*
- *How will any differences in safety risk among potential crew transportation systems be addressed, even if those systems meet safety standards?*

Mr. John Marshall, a member of the Aerospace Safety Advisory Panel who testified at the hearing made a comment in his prepared statement: *“there is no cookie-cutter approach to safety in space.”* Mr. Marshall articulated in his prepared statement several challenges that need to be addressed in ensuring the safety of NASA astronauts on commercial crew transportation providers to low-Earth orbit:

- *“Establishing detailed safety requirements that NASA deems essential to safe flight. These must be in a clear and enforceable form that can be placed on contract(s) and tested for compliance.”*
- *“. . . establishing minimum acceptable safety levels to guide system designs and set the baseline for both NASA and their contractors as to what is ‘safe enough’ is critical.”*
- *“Even with clear safety requirements and levels, much of the inherent safety of complex systems like spacecraft depends upon the design choices and decisions where risks are weighed against performance, costs, and of course, schedules. An open and effective system has been developed within NASA to accomplish this. A similar process needs to be institutionalized by any commercial provider as well, whereby all potential hazards are properly vetted by both government and contractors. This will not be easy and may require more than the ‘hands off’ approach envisions by some.”*
- *“Establishing disciplined program and process-related checks and balances so that NASA can verify that the contractor has evidence of compliance with the launch vehicle design requirements in the as-built vehicle and successful completion of the activities necessary to demonstrate mission readiness.”*

In discussions about safety, there have been repeated references to NASA’s oversight of safety for any commercial crew system. Accordingly, in testimony to the Senate Committee on Commerce, Science, and Transportation’s May 12, 2010 hearing on the future of U.S. human spaceflight, Dr. John Holdren, Director of the Office of Science and Technology Policy said, *“Safety will remain under the oversight of NASA. This gentleman on my left was in charge of safety for the Astronaut Corps when he was an astronaut. He knows how important that is. While Charlie Bolden is Administrator of NASA, there’s going to be no shortfall in the oversight of the private sector in delivering astronauts to Earth orbit in terms of safety. I just wanted to make that one point because it has come up from time to time.”* What “oversight” means in terms of NASA’s role and the costs to accomplish the oversight have not been discussed and needs to be understood.

##### 5. *Should Congress Support NASA’s Advanced Technology Initiatives?*

According to NASA, the agency’s Exploration Systems Mission Directorate (ESMD) will manage activities aimed at advancing technologies needed to expand human exploration opportunities, reduce mission costs, and contribute NASA innovation to broader national challenges and applications, will be funded in and managed by ESMD. ESMD’s Exploration Technology and Demonstrations activities are proposed to be funded at \$652.4 million in FY 2011; a total of \$7.82 billion is projected for the period of FY 2011 through FY 2015 to develop and carry out flagship technology projects.

ESMD will also lead research and development (R&D) activities related to space launch propulsion technologies. The agency proposes in its budget justification that this propulsion R&D effort include development of a U.S. first-stage hydrocarbon engine for potential use in future heavy lift (and other) launch systems, as well as basic research in areas such as new propellants, advanced propulsion materials manufacturing techniques, combustion processes and engine health monitoring. The proposed FY 2011 funding level for heavy lift and propulsion technology is \$559 million; a total of \$3.1 billion is projected for the period of FY 2011 through FY 2015. The April 15th plan included a decision date for a heavy lift vehicle by 2015. The issues related to heavy lift are described in a later section of the charter.

In addition, the FY 2011 budget request proposes a program of robotic precursor missions to send spacecraft to *“to candidate destinations for human exploration such*

as the Moon, Mars and its moons, Lagrange points, and nearby asteroids to scout targets for future human activities, and identify hazards and resources that will determine the future course of expanding human civilization into space.” The FY 2011 budget plan proposes an investment of \$125 million in FY 2011 and a total of about \$3 billion for FY 2011- 2015 on the robotic precursor program. The revised April 15th plan makes no changes to the proposed robotic precursor mission program.

#### *Issues Related to Advanced Technology Initiatives*

- In his testimony to the Senate Commerce, Science and Transportation Committee hearing on May 12, 2010, Administrator Bolden provided a list of the initial technology development projects that will be pursued as part of the advanced technology programs as well as list of the dates by which those projects will be completed. His prepared statement, however, cautions that the initial plans may change: *“Please note these are preliminary ESMD plans that may need to be modified following finalization of Agency plans regarding the restructuring of the Orion crew capsule.”*
- A recently released pre-publication version of a report by the National Academies, *Capabilities for the Future. An Assessment of NASA Laboratories for Basic Research* stated that *“The fundamental research community at NASA has been severely impacted by the budget reductions that are responsible for this decrease in laboratory capabilities, and as a result NASA’s ability to support even NASA’s future goals is in serious jeopardy.”* The study found that *“Over 80 percent of NASA facilities are more than 40 years old and need significant maintenance and upgrades to preserve safety and continuity of operations for critical missions.”* The report further stated that *“Deferred maintenance grew from \$1.77 billion to \$2.46 billion from 2004 to 2009, presenting a staggering repair and maintenance bill for the future.”* In addition, *“The equipment and facilities at NASA’s fundamental research laboratories are inferior to those . . . at comparable laboratories at DOE, at top-tier universities, and at many corporate research institutions.”* The president’s budget request does not appear to contain specific funds to deal with the facilities issues raised in the National Academies report.
- In his prepared statement to the Subcommittee on Space and Aeronautics’ hearing held on March 24, 2010, Mr. A. Thomas Young, Lockheed Martin (ret.), stated: *“The technology program identified in the proposed budget lacks definition and focus.”*

Congress needs the details on the basis and justification for the funding levels proposed for the technology programs, an understanding of the priorities for the programs and how they relate to the overall strategy and the implications of the need to fund a crew rescue vehicle on the technology initiatives. To date, this information has not been provided.

#### 6. *Should Congress Support the Plan to Make a Decision on a Heavy-Lift Vehicle by 2015?*

The Constellation Program includes the Ares V cargo launch vehicle which, according to the FY 2010 budget request for NASA, *“is designed to provide the heavy-lift capability for the Constellation architecture. The vehicle consists of a 6-engine core stage, two five-and-half segment solid rocket boosters, and an Earth departure stage (EDS) powered by a restartable J-2X engine. The EDS serves as the vehicle’s second stage, and is key to injecting the lunar lander and EDS stack into the low Earth orbit staging for rendezvous and dock with Orion. After the EDS performs the trans-lunar injection burn for the lander and Orion, it will be jettisoned.”*

The proposed human spaceflight plan does not include development of a heavy-lift vehicle. Instead the plan focuses on research and development in heavy-lift capabilities that would inform a decision on a launch vehicle. This is a point of departure from the Augustine committee report—often referenced as a key input into the proposed new plan—which included the importance of a heavy-lift launch vehicle among its principal findings. Mr. Augustine noted in testimony to the Senate Committee on Science, Transportation, and Commerce on May 12, 2010 that a key difference between the Augustine committee’s Option 5B and the administration’s plan is that: *“One is that our option went ahead with the development of the heavy-lift launch vehicle right away, rather than wait up to 5 years.”*

To demonstrate a concrete timetable and commitment for expanding human exploration further into space, the president announced in his April 15, 2010 remarks that, in addition to investing in heavy-lift technologies, NASA would *“finalize a rocket design no later than 2015 and then begin to build it. That’s at least two years earlier than previously planned . . . .”* The Office of Science and Technology Fact

Sheet on the president's April 15th address stated that *"This new rocket would eventually lift future deep-space spacecraft to enable humans to expand our reach toward Mars and the rest of the Solar System. This new rocket would take advantage of the new technology investments proposed in the budget—primarily a \$3.1 billion investment over five years on heavy-lift R&D."* That Fact Sheet calls out *"development of a U.S. first-stage hydrocarbon engine for potential use in future heavy lift (and other) launch systems."*

While the date of 2015 has been proposed as a decision point on the heavy-lift vehicle, it is not clear what that decision point means.

- In his prepared statement for the May 12, 2010 Senate Commerce, Science and Transportation hearing on U.S. human spaceflight plans, Dr. John Holdren, director of the Office of Science and Technology Policy, stated: *"The President also directed in his speech that NASA be in a position to select a heavy-lift rocket design by no later than 2015 for its future mission beyond Earth's orbit."* Dr. Holdren's statement went on to say that *"It is currently anticipated that this decision would set the general configuration of the vehicle, as well as target performance levels and other attributes. A more detailed and mature design for this vehicle likely would need to be completed following this initial decision, as part of a subsequent development effort."*
- In his prepared statement for the Senate hearing, Mr. Bolden said, *"the President specifically recognized the need for a heavy lift launch capability to carry humans beyond LEO by requiring a decision a vehicle design no later than 2015. Such a decision would include setting performance goals, identifying lift capability and selecting the general vehicle design—work that will ultimately lay the path for launching a spacecraft for crewed missions into deep space."*

By 2015, will NASA be in the position of building a vehicle, having completed most of the design and development process, or will NASA be in the position of just having defined which type of vehicle to design and develop? What is the return on the \$3.1 billion investment that Congress is being asked to support? These potentially different decision milestones in 2015 will have significant implications for the timeline of developing a heavy-lift vehicle to support exploration beyond low-Earth orbit and to achieve the administration's goal of human travel to a near-Earth asteroid by 2025.

#### *What Additional Information Does the Congress Need Regarding the Proposed Heavy Lift Launch Vehicle?*

NASA's May 2010 Request for Information on "Heavy Lift Launch System and Propulsion Technology" requests that industry *"Provide information regarding your potential launch or space transportation architectures (expendable, reusable, or a hybrid system) that could meet multiple customer needs (e.g., NASA, DoD, and Commercial)."* The Request for Information raises a number of questions: What is NASA's strategy for developing heavy-lift capability? Will DOD co-fund the development? Will the system be designed to meet multiple agency requirements, and if so, what are the advantages and disadvantages to this approach? How does the involvement of other agencies and the commercial sector affect the timeline and process for moving forward on a heavy-lift architecture?

In addition, according to NASA's planning timeline, NASA would fund development leading to a hydrocarbon engine demonstration that would occur in the 2015 timeframe; an operational hydrocarbon engine would be available in the early 2020s. NASA has not provided a rationale for completing an engine development program in parallel with developing a heavy-lift launch architecture that may or may not use that engine. Important questions remain regarding how an engine research and development program will proceed and when a heavy-lift vehicle would be available to support crewed missions beyond low-Earth orbit. NASA has explained that prior to sending a crewed mission to an asteroid in 2025, several crewed precursor flights would be needed including cislunar and circumlunar missions. Without supporting details to establish when the required spacecraft, heavy lift vehicle and other required systems will be in place, the timeline for achieving a human mission to an asteroid must remain uncertain.

Congress needs to understand:

- *When will a heavy-lift vehicle need to be ready, including an operational new engine if one is used, in order to support initial circumlunar and cislunar missions in preparation for a crewed mission to an asteroid in 2025? Is NASA's plan viable?*
- *What are the estimated costs of developing a new engine and how do they compare to the anticipated long-term cost savings for that engine? How does it*

*compare to the cost of pursuing evolvable heavy lift capabilities using the Constellation architecture approach?*

- *When will a crew exploration vehicle for travel beyond low-Earth orbit need to be ready to support initial circumlunar and cislunar missions proposed to take place prior to 2025? When does a decision on that vehicle and subsequent development need to take place to support that timeline? Is NASA's plan viable?*
  - *Will the success or failure of heavy lift research and development and other advanced technologies, such as in-space refueling, dictate where and when human exploration missions can be conducted?*
  - *Will the heavy lift vehicle be a government or commercially provided system?*
7. *To What Extent Can the Plan that Congress is Being Asked to Support Be Executed Within the Proposed Budget?*

Among its principal conclusions the Augustine Committee found that:

- The current U.S. human spaceflight program is on an “*unsustainable trajectory*,”
- “*Human exploration beyond low-Earth orbit is not viable under the FY 2010 budget guideline*,” and
- “*Meaningful human exploration is possible under a less-constrained budget, increasing annual expenditures by approximately \$3 billion in real purchasing power above the FY 2010 guidance*.”

The goal of a sustainable human spaceflight program is stated as a recurring theme of the FY 2011 budget request: “*The Exploration Systems Mission Directorate (ESMD) will lead the Nation on a course of discovery and innovation that will provide the technologies, capabilities and infrastructure required for sustainable, affordable human presence in space*.” Following the president’s remarks on revisions to his proposed human spaceflight strategy, Presidential Science Advisor, Dr. John Holdren characterized the president’s new plan as “*more flexible, more practical, more productive, and more affordable, but also more visionary*” than the existing plan.

According to Mr. Augustine, who spoke at the April 15th Kennedy Space Center event, the overall portfolio of the proposed plan is “very close to” the Augustine committee’s proposed option 5B. As described in the Augustine committee report, option 5B “*employs an EELV-heritage commercial heavy-lift launcher and assumes a different (and significantly reduced) role for NASA. It has an advantage of potentially lower operational costs, but requires significant restructuring of NASA . . . . The choice between NASA and EELV heritage is driven by potentially lower development and operations cost (favoring EELV-heritage systems) is driven by potentially lower development and operations cost (favoring the EELV-heritage systems) vs. continuity of NASA’s system design, development and mission assurance knowledge and experience, which would provide higher probability of successful and predictable developments (favoring NASA systems). EEL V-heritage launch systems, due to their lower payload performance, would require significantly greater launch and mission complexity to achieve the same total mass in orbit. The EELV option would also entail substantial reductions in the NASA workforce and closure of facilities necessary to obtain the expected cost reductions*.”

It is worth noting that DOD is reported to be developing plans for replacing its existing EELVs due to escalating costs of the EELV program. Furthermore, in the near term, DOD has expressed concern about the impact producing a human-rated EELV might have on the Air Force. In a recent interview in *Defense News*, the Air Force’s Deputy Undersecretary for Space Programs said:

*“If some commercial company or companies want to use the EELV for human access to the space station, we’d have to look very closely at changes to the rockets’ design in order to accommodate people. And any of those changes we’d have to manage very closely so that they don’t ripple in to the Air Force design, which has been very successful with 31 successes out of 31 attempts. My view is, if it works, don’t fix it.”*

When it analyzed the integrated options described in its report, including option 5B, the Augustine committee used two budget scenarios: the FY 2010 budget request for human spaceflight, as directed within the Augustine committee’s charter, and a “*less-constrained planning budget*” that increased “*from the FY 2010 budget number to a sum \$3 billion higher in 2014, and then rose at an expected inflation rate of 2.4 percent thereafter*”.

Table 1, below, shows the year by year budget figures projected for the Augustine committee’s less constrained scenario, the FY 2010 budget request, extended with inflation (as prepared by the Aerospace Corporation for the Augustine committee),

and the FY 2011 budget request, also extended with inflation. The budget figures for the Augustine committee's less constrained scenario and the FY 2010 budget request include the Space Shuttle, ISS, total Exploration budgets, and Exploration infrastructure sustainment at KSC. The FY 2011 budget column includes the same elements, the 21st Century Launch Complex and half of the Space Technology Program (minus the Innovative Partnership Program budget), with the assumption that half of Space Technology investments will be devoted to Science. What becomes clear from Table 1 is the growing gap between what the Augustine committee found was necessary for "*meaningful human exploration*" and what is requested within the FY 2010 and FY 2011 budgets for NASA's human spaceflight programs and exploration technology development as one looks at the outyear budget totals. While the overall FY 2011 NASA budget includes a \$6 billion increase over five years above the FY 2010 budget, Table 1 shows a significant gap between the Augustine committee's less constrained scenario and the FY 2010 and FY 2011 budget projections for human spaceflight/ technology programs. Under the administration's FY 2011 budget request, the new strategy proposed for human spaceflight, while similar to the Augustine committee's Option 5B, would be funded at a level that falls almost \$11 billion below the Augustine committee's projected resource need for that content within the first five years (from FY 2010–FY 2015) of implementation. That gap grows to \$27 billion over ten years and by FY 2025, the FY 2011 budget guidance falls \$47 billion short of what the Augustine committee determined would be necessary for a meaningful exploration program.

As part of its conclusions, the Augustine committee found that there was no "*reasonable exploration program (e.g., with different heavy-lift vehicles, or a different exploration destination)* [that] *would fit within the FY 2010 budget guidance.*" In addition, in the chapter on "Concluding Observations" the Augustine committee states that "*Perhaps the greatest contributor to risk in the space program, both human and financial, is seeking to accomplish extraordinarily difficult tasks with resources inconsistent with the demands on those tasks.*" Mr. Augustine echoed this guidance in his testimony on May 12, 2010 to the Senate Committee on Commerce, Science, and Transportation: "*The most important request I would make to this Committee on behalf of my colleagues on the Human Space Flight Committee was that whatever program is approved, that its goals match the budget. Otherwise, I think we'll all be back here ten years from now having this same discussion.*" The comparisons shown in Table 1 do not provide grounds for confidence that the proposed FY 11 strategy is sustainable, affordable and matched to the resources requested for it.

Table 1. Comparison of Budgets for Human Spaceflight/Technology

(all in millions of \$)	Augustine Report (Less Constrained Options)	Change From Previous Year (Augustine)	FY2010 Budget	Change From Previous Year (FY10)	FY2011 Budget	Change From Previous Year (FY11)
Assumed Inflation (%)	2.40		1.40		1.80	
FY2010	9,387.20		9,387.20		9,236.20	
FY2011	9,774.00	386.80	9,024.00	-363.20	8,647.90	-588.30
FY2012	10,317.00	543.00	8,816.00	-208.00	8,557.10	-90.80
FY2013	10,867.00	550.00	8,617.00	-199.00	8,681.30	124.20
FY2014	11,681.00	814.00	8,681.00	64.00	8,978.20	296.90
FY2015	11,961.00	280.00	8,802.00	121.00	9,067.10	88.90
FY2016	12,248.00	287.00	8,925.23	123.23	9,230.31	163.21
FY2017	12,542.00	294.00	9,050.18	124.95	9,396.45	166.15
FY2018	12,843.01	301.01	9,176.88	126.70	9,565.59	169.14
FY2019	13,152.00	308.99	9,305.36	128.48	9,737.77	172.18
FY2020	13,467.65	315.65	9,435.64	130.28	9,913.05	175.28
FY2021	13,790.87	323.22	9,567.73	132.10	10,091.48	178.43
FY2022	14,121.85	330.98	9,701.68	133.95	10,273.13	181.65
FY2023	14,460.78	338.92	9,837.51	135.82	10,458.05	184.92
FY2024	14,807.84	347.06	9,975.23	137.73	10,646.29	188.24
FY2025	15,163.22	355.39	10,114.88	139.65	10,837.93	191.63
Aggregate FY2010 Through FY2015	63,987.20		53,327.20		53,167.80	
Aggregate FY2010 Through FY2020	128,239.86		99,220.49		101,010.97	
Aggregate FY2010 Through FY2025	200,584.42		148,417.53		153,317.85	
	Through FY2015	Through FY2020	Through FY2025			
Difference in Aggregates Augustine -FY10 Budget	10,660.00	29,019.37	52,166.89			
Difference in Aggregates Augustine -FY11 Budget	10,819.40	27,228.89	47,266.56			
Difference in Aggregates FY10 Budget - FY11 Budget	159.40	-1,790.48	-4,900.33			

Sources: The Aerospace Corporation, NASA, and "The Economic Assumptions Underlying the Fiscal 2011 Budget, Christina D. Romer, Chair, President's Council of Economic Advisers, February 1, 2010."

8. *What Will Be the Impacts to the Human Spaceflight Workforce and Industrial Base Under the Proposed Human Spaceflight Strategy?*

The retirement of the Space Shuttle and the proposed direction for NASA will have major implications for the U.S. aerospace workforce and space industrial base. In conceiving the Constellation Program, NASA integrated measures to facilitate the transition of the Space Shuttle workforce to Constellation; the industrial base was also considered. In implementing Constellation, NASA had established a bridge so that a number of Shuttle and Space Station employees could devote a portion of their time to developing experience and skills that are relevant to the Constellation Program and that will facilitate their eventual transition to Constellation.

The proposed new direction for NASA's human spaceflight programs raises new issues and questions about the critical skills and knowledge of human spaceflight operations that will need to be sustained over time, the ability to attract new talent to the aerospace workforce and the potential state of the U.S. space industrial base. In particular, what are the critical workforce skills and industrial capabilities that need to be preserved as national assets, and what are the most effective ways to preserve those assets? What would any significant cutback or change in direction from the current Constellation Program mean for the aerospace workforce and space industrial base? These issues and questions were examined in a Committee on Science and Technology hearing on December 10, 2009 on *Decisions on the Future Direction and Funding for NASA. What Will They Mean for the U.S. Aerospace Workforce and Industrial Base?*

As Subcommittee on Space and Aeronautics Chairwoman Giffords stated in her opening remarks:

- *“Make no mistake about it. The decisions we collectively make about the future of our space program will have a lasting impact on our workforce, our industrial base, and our standing in the world.*
- *As a result, I want our witnesses to give us their views on what we need to consider when making those decisions so that the outcome will inspire our best and brightest to pursue careers in aerospace-careers that will be vital to our future competitiveness, national security, and quality of life.”*

Witnesses at that hearing commented on the link between the NASA workforce and industrial base and national security, how long-term experience affects the success of human spaceflight and the need for continued, engaging participation in inspiring programs to maintain and pass on that experience to the next generation.

Mr. A. Thomas Young, Lockheed Martin (ret.) stated:

- *“. . . spaceflight is not a typical technological activity. Because of the special characteristics of spaceflight . . . a workforce is required that has the culture and capabilities aligned with these characteristics. A workforce with the necessary intellectual strengths and possibly even more important, the experience and longevity to establish the sensitivity as to what is required for spaceflight success. Today in government, universities and industry we have such a workforce. It has evolved over decades of extraordinary successes and tragic failures . . . . It is truly a national treasure. Without a challenging and meaningful space program, this national capability will atrophy.”*

Ms. Marion Blakey, President and Chief Executive Officer of the Aerospace Industries Association stated:

- *“NASA is linked to the health of our industrial base . . . . we must also view these jobs as a national resource critical to our nation’s technological capability and our national security. Aerospace talent lost to other industries may be unrecoverable; new workers may take years to train. Additionally, if we lose certain facilities that manufacture high-tech technologies, it may take years and additional resources to bring them back.”*
- *“this decision [on human spaceflight], has a genuine impact on our national security because you must remember that some of these particularly smaller companies with unique capabilities and technologies . . . in fact also support that fragile national security supply chain.”*

Dr. Richard Aubrecht, Moog Inc. stated:

- *“The people that we had that did the Space Shuttle and did the Apollo program, they are about to retire, and the thing we are looking for the Constellation to be is the transition to the next generation of people and to do the mentoring . . . It goes from person to person. It is not in the drawings.”*

Although the administration has proposed a number of steps to address workforce issues, the following section illustrates the immature status of some of those proposals and an overall lack of clarity to date on how the workforce initiatives will work in an integrated fashion.

#### *How Many New Jobs Will the Proposed Human Spaceflight Plan Create?*

The president’s revised plan for NASA *“leads to more than 2,500 additional jobs in Florida’s Kennedy Space Center area by 2012”* and *“Jumpstarts a new commercial space transportation industry to provide safe and efficient crew and cargo transportation to the Space Station . . . projected to create over 10,000 jobs nationally,”* according to the OSTP Fact Sheet.

In addition, *“the Administration is launching a \$40 million, multi-agency initiative to help the Space Coast transform its economy and prepare its workers for the opportunities of tomorrow,”* according to an OSTP Fact Sheet on Florida’s Space Workers and the New Approach to Human Spaceflight. Accordingly, in his remarks at the Kennedy Space Center on April 15th, the president proposed *“a \$40 million initiative—led by a high-level team from the White House, NASA, and other agencies—to develop a plan for regional economic growth and job creation.”* He directed the plan to be delivered to him by August 15, 2010. In his prepared statement for the May 12, 2010 Senate Commerce, Science and Transportation Committee hearing on NASA’s human spaceflight plans, Mr. Bolden stated that *“The \$40 million for this initiative will be taken from the funds requested for Constellation transition in the original FY 2011 Presidential budget request.”*

On May 3, 2010, The White House established a Task Force on Space Industry Workforce and Economic Development *“to develop, in collaboration with local stakeholders, an interagency action plan to facilitate economic development strategies and*

*plans along the Space Coast and to provide training and other opportunities for affected aerospace workers so they are equipped to contribute to new developments in America's space program and related industries. The Secretary of Commerce and the Administrator of NASA shall serve as Co-Chairs of the Task Force." The program "shall be implemented consistent with applicable law and subject to the availability of appropriations."*

As part of its functions, the Task Force is directed to *"provide leadership and coordination of Federal Government resources to facilitate workforce and economic development opportunities for aerospace communities and workers affected by new developments in America's space exploration program."* In addition, the Task Force is directed to develop a plan that, among other things, *"recommends how best to invest \$40 million in transition assistance funding to ensure robust workforce and economic development in those communities within Florida affected by transitions in America's space exploration program"*. No similar initiatives or funds have been announced for other regions affected by the cancellation of Constellation.

NASA has not provided details on the rationale for the estimated jobs to be created, the types of jobs that will be created, and the extent to which the new jobs at the Kennedy Space Center will help offset the workforce decline that will follow the Space Shuttle retirement. An April 13, 2010 *New York Times* article notes that a senior administration official pointed to a study conducted by the Tauri Group, a consulting firm, and financed by the Commercial Spaceflight Federation, as the source of the estimated 10,000 jobs to be created by the commercial space transportation industry. It is not clear whether NASA or the administration has independently verified this estimate as part of its projected level of jobs to be created through commercial crew and cargo programs.

In addition, the proposed new strategy—specifically the cancellation of the Constellation Program—reportedly could have significant implications for the health of the solid rocket motor industrial base, which also supports ballistic missile programs. At a February 25, 2010 Committee on Science and Technology hearing on "NASA's Fiscal Year 2011 Budget Request and Issues," the Committee requested that the Administrator provide details on the extent to which NASA consulted the Department of Defense on the FY 2011 budget plan and the implications it will have on the industrial base and with whom in the Defense Department NASA consulted. NASA has not yet provided those details.

#### *Questions and Information Needed to Inform Congress' Decision*

- *To what extent do the projected commercial-sector jobs preserve the critical U.S. knowledge base of human spaceflight operations?*
- *What types of jobs would the new positions involve and at what skill levels? To what extent would those commercial-sector jobs help mitigate the projected job losses to be experienced by the retirement of the Space Shuttle and the proposed cancellation of the Constellation program?*
- *What assumptions, if any, have been made about the geographical locations of the projected new commercial-sector jobs?*
- *Is the Space Industry and Workforce Economic Development initiative expected to require funding beyond FY 2011, and if so how much?*
- *Which agency(ies) will be in charge of implementing this plan?*

Chairman GORDON. This meeting will come to order, and good morning, everyone.

As our first order of business, I want to remind everyone that given the importance of the subject of this hearing, it should come as no surprise that we have gotten some interest from members outside of this Committee, and it is the intent of us to try to accommodate them the best we can in terms of space and time. I also want to remind everyone that the non-Committee members will only be recognized after all the Committee members have an opportunity to be recognized, and if necessary, they may have to put their statements in the record. So without objection, Mr. Posey, Mr. Bishop and Dr. Griffith will be permitted to join us on the dais for this hearing.

Now I would like to yield to Mr. Rohrabacher for a recognition.

Mr. ROHRABACHER. Thank you very much, Mr. Chairman.

I would like to take this opportunity to point out in our audience today we have with us Apollo astronaut Rusty Schweickart, and Rusty flew in Apollo 9. Rusty, could you stand up and say hello to us? Thank you.

Rusty flew in Apollo 9, testing critical procedures and systems which enabled the future success of Apollo programs. He is today chairman of the board of the B-612 Foundation, a nonprofit foundation that champions the development and testing of spacecraft concepts that are designed to protect the Earth from near-Earth objects and asteroid impacts. Thank you very much for being with us today.

And Mr. Chairman, I have a statement by Mr. Schweickart that I would like to submit for the record.

[Information follows prepared statement of Chairman Gordon.]

Chairman GORDON. With no objection, so ordered.

Mr. ROHRABACHER. Thank you very much.

Chairman GORDON. When the fiscal year 2011 NASA budget request was released almost four months ago, it contained major changes to the NASA program that had been authorized and funded by Congress over the past five years. Among those changes, the Administration's request proposed canceling the Constellation-based exploration program on the grounds that it was unexecutable under foreseeable budgets. In contrast, the proposed new budget for NASA was described as a budget that puts NASA on a sustainable path for space exploration.

Since that time, this Committee as well as other committees of the Congress, have been trying to get the information we need to make informed decisions about the Administration's plan as we prepare for authorization and appropriations actions. When we had Administrator Bolden before us in February, there was precious little information and analysis that NASA could provide us in support of that budget request. When Chairman Giffords had NASA testify in March on the proposed new plan for human spaceflight, the outcome was the same: more new questions than answers.

Then on April 15, the president announced revisions to his NASA plan, adding a new crew rescue vehicle development program, a human mission to the near-Earth asteroid by 2025, and a decision by 2015 on the development of a new heavy lift launch vehicle, in

essence, directing NASA to pursue a program very similar to one of the options proposed by the Augustine Committee.

There are legitimate debates that members can have concerning the choices made in the President's plan about which destinations to pursue, the appropriate role of the commercial sector, and what type of technology program makes the most sense. Yet those debates ultimately won't matter unless the Administration's plan actually is doable under the Administration's proposed budget. It does no good to cancel a program that the Administration characterizes as unexecutable if the program is simply replaced with a new plan that can't be executed either.

That is the issue before us today, and Administrator Bolden, to be blunt, the burden of proof is on your shoulders to make the case that you have an executable program. So what we need to hear from you, and let me cite three specific issues. As you know, one of the most significant findings of the Augustine Committee was, and I quote, "Human exploration beyond low-Earth orbit is not viable under the FY 2010 budget guideline."

We have now taken a close look at your proposed human spaceflight plan and technology development budget plan, and this is what we have found. Your budget for human spaceflight and technology provides about the same amount of funding through fiscal year 2015 as the not viable fiscal year 2010 budget guidance. Equally importantly, your budget guidance program through 2025, the date of your proposed first human mission to an asteroid, is \$40 or 50 billion lower than the amount the Augustine panel determined would be needed to implement any of its exploration options.

Second, in his April 15th speech, the President directed NASA to develop a new crew rescue vehicle for the ISS that would be flying within the next few years, but he didn't add any money to your budget to do it. And I understand that NASA's preliminary estimate indicates that it could cost \$5 to \$10 billion to develop such a vehicle, and that the number doesn't include the annual cost to launch it and to operate the vehicle once it is operational. That is not to argue that we shouldn't be developing a spacecraft that can provide the basis for exploration beyond low-Earth orbit. One clearly will be needed. But it is another troubling indication that the plan that has been sent over to Congress has a great many loose ends and unexamined assumptions.

Third, the fiscal year 2011 budget plan assumes that multiple commercial crew systems can be developed over the next five years for a total cost of \$6 billion. However, analysis done by the Aerospace Corporation and even NASA's own estimate for the development cost of a simple crew rescue vehicle argue that the proposed commercial crew development budget is likely to be low by a factor of two or more.

The burden of proof has to be on you and the White House to justify the cost estimate, and so far we have not seen any hard analysis from the Administration that would give us confidence that it can be done for the amount budgeted. Given your statement that you will do what is needed to make the commercial providers succeed, the consequences of such an underestimation could be devastating to the rest of NASA's programs.

We all share the goals of inspiring and innovating and exploring. Let me be clear: I have no interest in having to have another Augustine Committee in five years. Your task today is to convince this Committee that this is truly well thought out, responsible budget with an executable plan.

Before turning to Ranking Member Hall for his opening remarks, I want to note for the record that the Committee also invited OSTP Director Holdren to testify at this hearing, but Dr. Holdren was unavailable due to travel plans.

In addition, I want to inform members that I plan to insert into the record for this hearing several items that were submitted to the Committee, including a statement by Dr. Buzz Aldrin, a letter from Dr. Russell Schweickart, a letter from the Planetary Society, a joint statement by several space organizations, and a letter from Governor Bill Richardson of New Mexico.

[The prepared statement of Chairman Gordon follows:]

PREPARED STATEMENT OF CHAIRMAN BART GORDON

Good morning. When the Fiscal Year 2011 NASA budget request was released almost four months ago, it contained major changes to the NASA program that had been authorized and funded by Congress over the past five years. Among those changes, the Administration's request proposed canceling the Constellation-based exploration program on the grounds that it was "unexecutable" under foreseeable budgets.

In contrast, the proposed new budget for NASA was described as a budget that puts NASA on a "sustainable path" for space exploration.

Since that time, this Committee, as well as other Committees of the Congress, have been trying to get the information we need to make informed decisions about the Administration's plan as we prepare for authorization and appropriations actions. When we had Administrator Bolden before us in February, there was precious little information and analysis that NASA could provide us in support of the budget request, and what was provided raised more questions than it answered. When Chair Giffords had NASA testify in March on the proposed new plan for human space flight, the outcome was the same—more new questions than answers.

Then on April 15th, the president announced revisions to his NASA plan, adding a new crew rescue vehicle development program, a human mission to a Near Earth asteroid by 2025, and a decision by 2015 on development of a new Heavy Lift launch vehicle—in essence, directing NASA to pursue a program very similar to one of the options proposed by the Augustine Committee.

There are legitimate debates that Members can have concerning the choices made in the president's plan about which destinations to pursue, the appropriate role of the commercial sector, and what type of technology program makes the most sense. Yet those debates ultimately won't matter unless the Administration's plan actually is doable under the Administration's proposed budget—that it actually is "executable" and truly puts NASA on a "sustainable path". It does no good to cancel a program that the Administration characterizes as "unexecutable", if that program is simply replaced with a new plan that can't be executed either.

That's the issue before us today, and Administrator Bolden, to be blunt, the burden of proof is on your shoulders to make the case that you have an executable program.

So what do we need to hear from you? Let me cite three specific issues:

As you know, one of the most significant findings of the Augustine Committee was that "*Human exploration beyond low Earth orbit is not viable under the FY 2010 budget guideline.*"

We've now taken a close look at your proposed human space flight and technology development budget plan, and this is what we've found:

Your budget for human space flight and technology provides about the same amount of funding through FY 2015 as the "not viable" FY 2010 budget guidance.

Equally importantly, your budget guidance through 2025—the date of your proposed first human mission to an asteroid—is \$40 to 50 billion lower than the amount the Augustine panel determined would be needed to implement *any* of its exploration options.

Second, in his April 15th speech, the president directed NASA to develop a new crew rescue vehicle for the ISS that would “be flying within the next few years”—but he didn’t add any money to your budget to do it.

I understand that NASA’s preliminary estimates indicate that it could cost \$5 to \$7 billion to develop such a vehicle, and that number doesn’t include the annual cost to launch it and rotate the vehicles once it is operational. That’s a big unfunded mandate to absorb in your budget over the next five years—you’ll need to take a billion to two billion dollars *per year* from elsewhere in your budget over the next five years to cover it.

To put the budgetary impact of that into perspective, if you eliminated all of the FY 11 funding for the Exploration Technology Demonstration program, the Robotic Precursors program, and the KSC 21st Century Space Launch initiative, you will have only covered \$1.2 billion of the shortfall. If the annual shortfall over the next five years is closer to \$2 billion, you would also need to eliminate the FY 11 increases for Space Technology, Aeronautics, and Earth Science.

That’s not to argue that we shouldn’t be developing a spacecraft that can provide the basis for exploration beyond low Earth orbit. One clearly will be needed. But it’s another troubling indication that the plan that has been sent over to Congress has a great many loose ends and unexamined assumptions that call its credibility into question.

Third, the FY 2011 budget plan assumes that multiple commercial crew systems can be developed over the next five years for a total cost of \$6 billion. However, analyses done by the Aerospace Corporation and even NASA’s own estimates for the development cost of a simple crew rescue vehicle argue that the proposed commercial crew development budget is likely to be low by a factor of two or more.

The burden of proof has to be on you and the White House to justify that cost estimate, and so far we have not seen any hard analysis from the Administration that would give us confidence that it can be done for the amount budgeted. Given your statements that you will do what is needed to make the commercial providers succeed, the consequences of such an underestimate could be devastating to the rest of NASA’s programs.

We all share the goals of inspiring and innovating and exploring. Let me be clear. I have no interest in having to have another Augustine committee in five years. Your task today is to convince this Committee that this is truly a well-thought out, responsibly budgeted, executable plan.

Before turning to Ranking Member Hall for his opening remarks, I want to note for the record that the Committee also invited OSTP Director Holdren to testify at this hearing, but Dr. Holdren was unavailable due to travel plans.

In addition, I want to inform Members that I plan to insert into the record of this hearing several items that were submitted to the Committee, including:

- A statement by Dr. Buzz Aldrin;
- A letter from Dr. Russell Schweickart;
- A letter from the Planetary Society;
- A Joint Statement by several space organizations;
- And a letter from Governor Bill Richardson of NM.

With that, I now recognize Ranking Member Hall for an opening statement.

[The information follows:]

The Way Forward: Achieving a Consensus on America's Future in Space

A White Paper by Buzz Aldrin, Apollo XI (draft 5/20/10 - rev1)

It is widely known that I support the President's new space agenda for civil space. I was proud to stand beside the President at the recent Space Summit, and to endorse his bold vision for space - a vision that I believe will enable us to maintain our pioneering leadership in this vitally important enterprise.

The President's approach supports many of the principles that I have long advocated, including - the opening of space to the private sector, the development of a strong technical foundation in science and technology that will enable our continued leadership in space, while also encouraging truly international collaboration with our space faring partners who would embrace this future, the implementation of a Flexible Path that will afford us opportunities for exciting missions beyond low Earth orbit (LEO), enabling journeys to: libration points and orbits whose characteristics afford exceptional opportunities for new space science platforms to unlock the secrets of the universe; human missions to asteroids; and, on to Mars and its two moons; or to other destinations that hold potential scientific or economic promise, such as the potential international commercial development of the moon - should this become a priority. It is a rich vision that I would hope that we could all embrace.

A number of my former colleagues, and other critics, have expressed concerns about the plan, and in particular, they express grave reservations about 'the Gap' - the end of the Space Shuttle Program, and the inability for the US to provide human access to space - save for limited flight opportunities and capabilities with our Russian partners, pending the maturing of the commercial space transportation capabilities, or other future systems to meet these needs.

Perhaps it is less widely known, that I also share this concern, and I have long advocated a number of potential alternatives to try to address this issue: For the very near-term, I have proposed extending, or commercializing, the space shuttle system, which would preserve the opportunity for reduced manifest (one or two flights per year) support of the International Space Station, while also preserving the capability to develop a shuttle derived heavy lift launch vehicle to meet our future space exploration needs, and as importantly, maintain the critical technical workforce that supports our nations space transportation capabilities. A capability that we are in grave danger of losing in the few months ahead...

Some now claim that the Space Shuttle Program has been dismantled to the extent that this is no longer a viable option. It is difficult to accept that reestablishing this capability would be more difficult than the development of an entirely new replacement vehicle.

At the other end, we could close the Gap by pursuing the development of a human-rated EELV launch capability that would be paired with a reusable, runway-lander, crewed spacecraft, while NASA turns its attention to its longer-term space transportation requirements. The EELV has proven to be a reliable launcher, and NASA has spent many years developing candidate reusable runway-landers, including the HL-20 and the X-38, so these concepts are also quite mature. If made a national priority, I believe this capability could be developed quickly, and this system could help reduce the devastating effects of the Gap. While initially developed by the government to address the critical need to fill the Gap, in the longer term, this system might be spun off to the commercial sector for its continued operations.

We have already endured a gap in human access to space following the termination of Apollo, and the eventual first flight of Columbia, with STS-1 on April 12, 1981. During this period our astronauts were Earthbound, while the former Soviet Union embarked on a series of space stations that allowed them to set records for human activity in space – many that still stand today. Our science program was also disrupted, as a many missions that were being designed for launch aboard Shuttle had to wait for its development and flight qualification.

We also faced two tragic gaps following the loss of Challenger and Columbia and their brave crews. We should learn from these experiences that it is essential to maintain US access to space, and I continue to be a fierce advocate for this need.

What should we do to address this urgent need? I believe that it is possible to find a compromise solution that might address the critical concern regarding the Gap: I would call upon the President to issue an Executive order, requiring that the USAF and NASA collaborate in the development of a launch capability to help fill the Gap. It would call for the USAF to work with NASA to human-rate the EELV, and to provide this launch capability to meet NASA's near-term human space access needs. It would direct NASA to undertake the rapid proto-flyte development of an HL-20 reusable, runway lander that would be mated to this vehicle to meet its LEO requirements, including supporting the ISS, until an alternate capability has been developed and demonstrated the ability to meet this critical requirement.

I would also continue with the President's current plan to take advantage of the investment that we have already made in the Orion capsule, and use this capability as a lifeboat, or Crew Return Vehicle (CRV), for ISS, so we can fully man space station and exploit its magnificent capabilities. This would also preserve the option to develop future derivative Orion capsules for future human exploration missions beyond LEO, where the higher reentry heating loads of aero capture would benefit from this configuration.

I would also ask the President direct NASA to update its space station and logistics resupply requirements study (the so-called 'Blue Book', developed by NASA/LaRC and ISS), to fully understand the long-term requirements to maintain ISS through

2020, and potentially beyond, and to examine these requirements with our international partners to determine how – collectively, we might meet these requirements. It is in our mutual interest to ensure that these requirements can be met, and to negotiate any agreements, or barter, to utilize internationally provided space transportation capabilities necessary to meet them.

Having addressed what I feel is the most divisive part of the President's new vision for space, I would call for my colleagues, and our nation, to get behind the new direction for NASA so we – together with our international partners and the emerging new commercial space industry, can continue the greatest enterprise in the history of man – the exploration of space for all mankind.

**RUSSELL L. SCHWEICKART**  
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14 October, 2010

Honorable Dana Rohrabacher  
Member, Committee on Science and Technology  
United States House of Representatives  
Rayburn House Office Building, #2300  
Washington, DC 20515

Dear Congressman Rohrabacher,

I write this letter, as an Apollo astronaut, to state my strong support for the proposed NASA human spaceflight program as modified by President Obama in his April 15, 2010 speech in Florida. It sets an inspiring new goals that move us into deep space, a goal to inspire a new generation of engineers and astronauts.

I, like many of my fellow astronauts, am greatly concerned that our nation's historic leadership in space exploration is eroding to the point where we will shortly lose that title. We Apollo-era people gave the United States everything we had to regain leadership in space from the Soviet Union back in the 60s and we hate like hell to see it drift away from us now.

I believe that on our current course the coming loss of US leadership in human space exploration is unavoidable. With this in mind the question of how best to regain that leadership breaks into two fundamental elements; assessing our current situation and choosing our direction going forward. In terms of relative importance I weigh these at 80% and 20% respectively.

Our current situation is akin to being on a dead end road. Instead of being on a path toward the goal we all seek, i.e. to regain our leadership position in human space exploration, we must recognize that we are (and have been) on a path to nowhere. We are confronted with arguments to deny and ignore the clear signs of this sad situation and even encouraged to accelerate along this futile path.

The alternative to this is support for the President's proposed plan. It recognizes and eliminates the waste of precious resources in the current program and heads us in a productive direction toward our desired destination. In other words, when you recognize you are on a dead end road, stop, turn around, and head in a direction more useful to your goal. Denial of this reality will guarantee an extended loss of leadership.

Are we, in fact, on a dead end road? In answering this critical question you should not overvalue either my opinion or the opinions of my fellow astronauts, but rather focus on the considered and thoughtful, and even hard-nosed, analysis of the panel of experts who dealt explicitly with this, the Augustine Committee on our

Human Spaceflight Program. Norm and his panel are very experienced and highly qualified academics, business leaders, astronauts, and space program executives. I have immense respect for them and their considered judgment. They performed a thorough, open and difficult review and analysis of where we are. Their conclusions were not reached lightly nor did they shy away from calling it as they saw it. I take their work and their conclusions very seriously and I believe you should as well.

As well as their long and hard review of where we are in our existing human spaceflight development the Augustine Committee also considered many options for a path forward. While not using the words "dead end" they concluded that the existing program would, even with \$5-7B of additional funding, not get us to the moon, let alone land or establish a base there until well into the 2030s... "if ever". And in the end, while not making specific recommendations, they rated their "flexible path" option, 5b, very highly. The Obama administration and NASA leadership ultimately decided on a program very similar to and based on the Augustine Committee's option 5b.

While I will not attempt to comment on many of the elements of the proposed program I would like to make a few specific comments which will inform the basis of my support and might prove helpful in your deliberation.

Virtually everyone involved in the future of our US human space exploration program shares the identical long term goal of the human exploration of Mars. The issue is now and has been choosing the best way to build to that ultimate capability. It is my belief that going back to the Moon (i.e. the Constellation landing and base program) is neither necessary nor appropriate nor feasible in this regard.

Technical arguments can and have been made to support this intermediate step, and they are not without justification and support. Nevertheless, in my opinion, the arguments for necessity are fundamentally weak, and in any event are overwhelmed by the widely held and devastating question "been there; done that... tell us why you're doing that again?" Why, after 60 years, should we be devoting incredible resources and effort to going back to the Moon instead of to a challenging, pioneering new goal? As Norm Augustine stated in the 12 May Senate hearings, the long term space program has to be supported on a continuing basis by the public, and the public simply will not maintain support to reliably sustain a monumental and expensive effort to do again what we did 60 years before. This is especially true of young people, who are hardly inspired by a goal of repeating their grandparent's achievements.

Happily there is an intermediate Mars trajectory which, in my opinion, makes much more sense. It is new and exciting and, I believe, will garner wide public support. That intermediate goal is to send our astronauts on a mission into deep space, to a near-Earth asteroid.

Deep space is a term easily used but not well understood. Orbiting the Earth, whether high or low, and even going out to the Moon is operating in Earth-space, or Earth/Moon-space. I.e. the gravitational field of the Earth dominates the behavior of all space objects. Deep space is dominated by the Sun. This is a new, and very different environment. Orbiting the Earth takes an hour and a half, or at

lunar distance 28 days. Orbiting the Sun takes a year, or at Jupiter's distance 12 years. Reaching deep space requires leaving earth space totally. Mars is in deep space. Sending astronauts to explore an asteroid (i.e. a near-Earth asteroid or NEO) requires us to go into deep space. By extending our capability into deep space to explore an asteroid we will be taking a big step beyond going to the Moon, but relatively speaking, a small step compared with going all the way to Mars. It is also important to note that sending astronauts to explore an asteroid is less expensive than a return to the Moon's surface. This is therefore, both an imaginative, new, and logical goal, and a natural step in developing the capacity for the human exploration of Mars. Furthermore the public interest and support for US astronauts exploring an asteroid, a new and very different "world", would be strong.

In addition to being a feasible and appropriate goal for human exploration, there are other extremely powerful reasons to identify asteroids as a primary new goal for space exploration. Specifically they occasionally threaten life on Earth as the result of an impact, they are fascinating scientific objects, and they contain (relative to the Moon's surface) a wealth of valuable resources which we may one day choose to access to minimize the cost of space operations. My own work over the past decade has been to assure that using our space capability we are able and prepared to divert an asteroid when we find one threatening an impact. This, however, is a fascinating discussion for another time. The point here is that near-Earth asteroids are a multi-faceted, fascinating and valuable intermediate step on our way to Mars, and a far more interesting and appropriate goal for human exploration than going back to the Moon.

Finally, I would like to comment on the issue of the "gap" and the proposed reliance on commercial providers to close the gap and re-establish our US human launch capability.

The sad state of our current space program, and the gap in particular, is a given. An unfortunate, but unavoidable given due to the complete mismatch between the program announced by President George W Bush in early 2004 and the inadequate funding which was subsequently sought and allocated since that time. As Norm Augustine testified in the Senate hearing on May 12, in the 4 years between the announcement of those ambitious goals and the time when his Committee conducted its comprehensive review of human space flight, the Ares launch vehicle development slipped between 3 and 5 years. This slip, combined with the planned termination of Space Shuttle operations in 2010 created and ultimately extended the "gap" in our nation's ability to launch astronauts into orbit to 7 years or more. This gap, during which time we will be dependent on the Russians to launch our American astronauts to the ISS, was created during the existing space program. It is a given and it cannot be eliminated.

The Obama program proposes, given realistic budget projections, to minimize this gap in indigenous US launch capability by transitioning from the past practice of NASA "owned and operated" launch services to leasing these services from US commercial companies. Whether or not a safe and reliable capability of this kind can be developed in this timeframe is yet to be seen. However, without a commitment to this shift in acquisition of launch services, NASA, and the US Government, will be locked into developing and providing well understood

transportation services which can and should rightly be relinquished to private enterprise. If NASA stays in this business, industry cannot compete. Taxpayer money will, in effect, be used to inhibit the development of an independent, private, commercial capability with a huge upside potential for jobs and, indeed, world industrial leadership.

NASA should, as proposed by the new space program, continue to encourage and assist US enterprise in meeting the performance and safety requirements inherent in flying both cargo and people to low Earth orbit without absorbing all of the cost. This cooperative effort would both minimize the existing gap and bring into being an exciting, new US industrial capability, replete with industrial innovation and job creation.

Is this risky? Of course it's risky. All space activity is risky. But wisely accepting and managing this risk will ultimately lead to a new and exciting US business capability which will be the envy of the world. The alternative is for NASA to continue to divert its precious human and economic capital to a challenging but very well understood transportation service rather than toward pioneering new and more advanced technology.

No program in the past 50 years has created more excitement in young people, more of a demand for education, or more technological innovation than the Apollo program. Apollo called out the best in all of us. Those of us who were fortunate enough to work directly and indirectly to meet President John F. Kennedy's goal will never forget the fantastic experience of giving our all to meet that grand challenge. Was that challenge bold and risky? "You betcha!" And indeed were it not for the demands of that challenge, including the uncertainties and inherent risks, we as a nation and a family of space geeks would not have come together as we did to make it a success. We are a nation of risk takers and innovators. It is in our blood.

Is going back to the Moon after a 60 year gap going to generate and maintain that same sort of excitement, innovation and determination? I do not believe so. Will setting a goal of sending American astronauts into deep space to explore an asteroid, up close and personal generate it. I do believe that it will.

I request that this letter be added to the testimony record for your 26 May, 2010 hearing on the Proposed NASA Human Spaceflight Plan.

Sincerely,

Russell L. Schweickart  
Apollo 9 Astronaut

Cc: Congressman Bart Gordon, Chair, Committee on Science & Technology  
Congresswoman Gabrielle Giffords, Chair, Subcommittee on Space & Aeronautics



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*Members are for identification purposes only.*

21 May 2010

Rep. Bart Gordon, Chair  
Rep. Ralph Hall, Ranking Minority  
U.S. House of Representatives  
Committee on Science and Technology

Dear Rep. Gordon and Rep. Hall,

Thank you for conducting the hearing to review the proposed NASA human space flight plan. In connection with this hearing and in support of the NASA plan, we would like to call to your attention the attached joint statement from one dozen organization representing large science and engineering constituencies as well as the public. The group includes America's largest science organization (AAAS) and the world's largest professional society devoted to aerospace (the American Institute for Aeronautics and Astronautics), and the largest citizen's space interest group, The Planetary Society.

The Planetary Society has provided testimony to Congress in support of this plan and we are appending that to this letter as well. The plan has aroused controversy, and it has also been greatly misunderstood. We believe that the science groups' joint statement shows that the space community is far more supportive than might be concluded from reading statements of a few individuals. While the negative effect of the Constellation contract cancellations is not to be minimized, the positive investment in future human space exploration will overcome the short-term effects. Under the new guidelines, space flight to low Earth orbit would be provided by the commercial sector as a service to support NASA, using their long experience and existing rockets as well as the entrepreneurial energy and investment of new companies. American participation in the International Space Station would be extended, guaranteeing the space station a customer and American astronauts a near-term destination, and presaging a future of international cooperation in space exploration ventures.

Thank you very much for your consideration,

Sincerely,

Jim Bell  
President

Bill Nye  
Vice-President

Louis Friedman  
Executive Director

## JOINT STATEMENT BY SPACE ORGANIZATIONS ON THE FY 2011 NASA BUDGET

May 20, 2010



We the undersigned, a diverse group of organizations with a vital interest in our Nation's space program, make the following statements:

- We strongly support the top line FY2011 NASA budget.
- We believe an important goal of the NASA budget is to accelerate the development of the intellectual capital of the United States by investing in a high-cadence exciting program.
- We are excited by the increases in science, aeronautics and technology initiatives.
- We believe both human exploration and research are important: destination, milestones, engagement and story matter.
- We believe this is an opportunity for NASA to craft the exploration strategy in partnership with science and applied science that includes the International Space Station, safe and cost-effective access to low earth orbit, robotic precursors, and other missions. Heavy lift launch and in-space servicing enable new realms of exploration and science.
- We believe it is critically important that the American people can and must participate and be engaged in the journey of discovery and exploration.

AMERICAN ASSOCIATION FOR THE ADVANCEMENT OF SCIENCE  
AMERICAN ASTRONOMICAL SOCIETY  
AMERICAN GEOPHYSICAL UNION  
AMERICAN INSTITUTE FOR AERONAUTICS AND ASTRONAUTICS  
AMERICAN SOCIETY FOR GRAVITATIONAL AND SPACE BIOLOGY  
ASSOCIATED UNIVERSITIES, INC.  
ASSOCIATION OF UNIVERSITIES FOR RESEARCH IN ASTRONOMY  
COMMERCIAL SPACEFLIGHT FEDERATION  
MARYLAND SPACE BUSINESS ROUNDTABLE  
NATIONAL SPACE SOCIETY  
THE PLANETARY SOCIETY  
SPACE FRONTIER FOUNDATION  
UNIVERSITIES SPACE RESEARCH ASSOCIATION

Chairman GORDON. With that, I now recognize Ranking Member Hall for an opening statement.

Mr. HALL. Thank you, Mr. Chairman, for holding this hearing on a very important topic of NASA's human spaceflight program, and I can't help but point out or reiterate that this room today holds in addition to Rusty that was just introduced and our first witness holds some of the really true heroes of all time and we are honored to have you here, and I hope my questions and my thrust is without acrimony but with great appreciation to each one of you.

I also want to thank you for assembling such a great panel, Mr. Chairman. I certainly welcome Administrator Bolden and I hope he can answer some of the many questions we have about the Presi-

dent's proposal, and we had the opportunity to talk with him yesterday. His time has always been available, and I am very appreciative of that.

I am also pleased to see two space heroes with us today, Neil Armstrong and Gene Cernan. These men are legendary astronauts and explorers who laid the whole foundation for our Nation's space exploration beyond low-Earth orbit, and I am honored that they have agreed to share their knowledge and their commitment and their passion with us today. I want to thank Tom Young for once again agreeing to testify before this Committee and sharing his knowledge and years of experience working with the government acquisition process.

It has now been nearly four months since the Administration proposed radical changes to NASA's human spaceflight and exploration programs. From the very beginning, it was clear that NASA's proposal lacked the sufficient detail that Congress would need to determine whether it was a credible plan, yet in spite of our best efforts to obtain more information from NASA, this situation has not improved. Indeed, the President's trip to the Kennedy Space Center on April 15th only added to the confusion as he laid out more aspirational goals but provided no clear idea of how they fit together or how the experts expect to ever pay for all these new ventures.

As such, I still have many basic concerns about our ability to access and use the International Space Station after the shuttle is retired. I remain concerned about the gap in the U.S. access to space, and I want to ensure that we can effectively use the enormous research capabilities of the International Space Station. In examining the President's plan, I still do not see a viable way to minimize the gap and provide for very exciting research on the International Space Station. The President's most recent decision to send an unmanned lifeboat to the space station at a potential cost of \$5 billion to \$7 billion does absolutely nothing to solve this problem and largely duplicates existing services provided by the Russians.

Although we have already spent nearly \$10 billion on the Constellation system and supported by Democrats and Republicans alike on this Committee and in this Congress that has achieved significant milestones and is well on its way to provided continued U.S. access to space, the Administration's continued decisions to cancel Constellation has further stalled development and jeopardizes our undisputed leadership in space.

As I have said many times before, I am concerned with the proposed commercial crew direction of the Administration. While I have long supported the development of commercial cargo operations, I believe it is prudent that we first test cargo capabilities before risking the lives of our astronauts on newly developed systems. I have not seen credible data to suggest that there is a viable market for commercial crew carriers, and in the absence of that data, I fear that we might be setting ourselves up for failure if and when the markets do not materialize. Anyone can claim to be able to take over commercial crews, and I have read a good bit of the ideas of another space hero and a very dear friend of mine, Buzz Aldrin, who supports commercial crew, but I am still looking for concrete data that they can finish what they start and will not be

coming back to the government for additional money if they take over.

Finally, in examining options beyond low-Earth orbit, I am unclear when we might see the development of a heavy lift system or whether NASA still considers the moon as a logical destination. We have been told that a new “game changing” technology development program will provide capabilities for accessing the far reaches of space but we have very few specifics on mission goals and direction. I hope Administrator Bolden has some of the answers that have been lacking up to now.

In the absence of a defensible, credible plan, I and many of our members continue to support the Constellation program as currently authorized and appropriated by successive Congresses. GAO will continue investigating whether NASA is improperly withholding funds and improperly applying the Antideficiency Act as a means of slowing Constellation work. I believe that Congress has been clear that it supports the unhindered continuation of Constellation until it authorizes an alternative program.

Mr. Chairman, I look forward to working with you over the next several weeks as the Committee begins to reauthorize NASA, and we can no longer wait for NASA to provide justification for its radical changes. Time is absolutely running out.

I want to wish you, Mr. Chairman, the very best and I want to thank you and express my gratitude to you for your undying efforts to preserve the right thing for us to do, and we all look forward to continuing. I look forward to today’s testimony.

I yield back my time, sir.

[The prepared statement of Mr. Hall follows:]

PREPARED STATEMENT OF REPRESENTATIVE RALPH M. HALL

Mr. Chairman, thank you for holding this hearing today on the important topic of NASA’s human space flight program.

I also want to thank you for assembling such an extraordinary panel of witnesses today. I want to welcome NASA Administrator Bolden, and I hope that he can answer some of the many questions that we have about the President’s proposal.

I am also pleased to see two space heroes with us today, Neil Armstrong and Gene Cernan. Both men are legendary astronauts and explorers who laid the foundation for our nation’s space exploration beyond low Earth orbit. I am honored that they have agreed to share their knowledge, their commitment, and their passion with us today. I also want to thank Tom Young for once again agreeing to testify before this committee and share his knowledge and years of experience working with the government acquisition process.

It has now been nearly four months since the administration proposed radical changes to NASA’s human space flight and exploration programs. From the very beginning it was clear that NASA’s proposal lacked the sufficient detail that Congress would need to determine whether it was a credible plan. Yet, in spite of our best efforts to obtain more information from NASA this situation has not improved. Indeed, the President’s trip to the Kennedy Space Center on April 15th only added to the confusion as he laid out more aspirational goals, but provided no clear idea of how they fit together or how he expects to pay for these new ventures.

As such, I still have many basic concerns about our ability to access and use the International Space Station after the Shuttle is retired. I remain concerned about the “gap” in U.S. access to space, and I want to ensure that we can effectively use the enormous research capabilities of the International Space Station. In examining the President’s plan, I still do not see a viable way to minimize the “gap” and provide for exciting research on the ISS.

The President’s most recent decision to send an unmanned “lifeboat” to the Space Station at a potential cost of \$5–7 billion does nothing to solve this problem and largely duplicates existing services provided by the Russians. Although we have already spent nearly \$10 billion on the Constellation system that has achieved signifi-

cant milestones and is well on its way to providing continued U.S. access to space, the Administration's decision to cancel Constellation has further stalled development and jeopardized our undisputed leadership in space.

As I have said many times before, I am concerned with the proposed commercial crew direction of this Administration. While I have long supported the development of commercial *cargo* operations, I believe that it is prudent that we first test cargo capabilities before risking the lives

of our astronauts on newly developed systems. I also have not seen credible data to suggest that there is a viable market for commercial crew carriers, and in the absence of that data I fear that we might be setting ourselves up failure if, or when, the markets do not materialize. Anyone can claim to be able to take over commercial crew, and I have read the good ideas of another space hero, Buzz Aldrin who supports commercial crew, but I am still looking for concrete data that they can finish what they start, and will not be coming back to the government for additional money if they take over.

Finally, in examining options beyond low Earth orbit, I am unclear when we might see the development of a heavy lift system, or whether NASA still considers the Moon as a logical destination. We have been told that a new "game-changing" technology development program will provide capabilities for accessing the far reaches of space, but we have very few specifics on mission, goals, and direction. I hope Administrator Bolden has some of the answers that have been lacking up to now.

In the absence of a defensible, credible plan, I and many of our members continue to support the Constellation program as currently authorized and appropriated by successive Congresses. GAO will continue investigating whether NASA is improperly withholding funds, and improperly applying the Anti-Deficiency Act as a means of slowing Constellation work. I believe that Congress has been clear that it supports the unhindered continuation of Constellation until it authorizes an alternative program.

Mr. Chairman I look forward to working with you over the next several weeks as the Committee begins to reauthorize NASA, and we can no longer wait for NASA to provide justifications for its radical changes. Time is running out.

I look forward to today's testimony, and I yield back my time.

Chairman GORDON. Thank you, Mr. Hall. You are a good partner.

Our first witness is Mr. Charles F. Bolden, Jr., who is the Administrator of the National Aeronautics and Space Administration, and Gen. Bolden, you have served your country with distinction in and out of uniform. We are glad you could be with us today, and I know you can breathe a better sigh of relief that the shuttle landed safely this morning. Congratulations for that. And so you may proceed.

**STATEMENTS OF CHARLES F. BOLDEN, JR., ADMINISTRATOR,  
NATIONAL AERONAUTICS AND SPACE ADMINISTRATION**

Mr. BOLDEN. Thank you, Mr. Chairman.

Mr. Chairman and members of the Committee, I want to thank you all for the opportunity to appear here today to discuss additional information about the President's fiscal year 2011 budget request for NASA. Following the President's important speech at the NASA Kennedy Space Center in Florida, I also want to comment about the outcome of that.

NASA is grateful for the support and guidance received from this Committee through the years and looks forward to working with you to implement the President's bold new direction for our agency. Given that you have my detailed written statement, I will try to keep my remarks brief this morning so that I leave time for your questions.

First, I would like to acknowledge the incredible contributions of my two astronaut colleagues on the next panel. Both Neil and

Gene, the first and last humans to set foot on the moon, have dedicated their lives to the challenging and often-unforgiving pursuit of space exploration and in doing so have improved the quality of life in America and inspired the next generation of explorations. They continue to contribute by remaining engaged and providing their remarks on today's important topic of the future of human space exploration. I appreciate their thoughts, and we talk often. It was very beneficial to have had the opportunity to discuss their concerns and to present them with a thorough brief on our plans for America's future in human spaceflight several weeks ago.

However, reasonable people can disagree and so I must respectfully disagree with some of their concerns and their opinions. The President's fiscal year 2011 budget request is good for NASA because it sets the agency on a sustainable path that is tightly linked to our Nation's interests. During his visit to the Kennedy Space Center, the President articulated a strong commitment to NASA's mission and the future of human spaceflight exploration. As we prepare to end the shuttle era, and we took an important step this morning when we successfully brought Atlantis home safely with her crew, we all should acknowledge its critical importance as a very productive step along America's path of becoming the pre-eminent space-faring Nation.

As my predecessor, Mike Griffin, has written in a draft tribute to the space shuttle, and I quote, "It was an enormous leap in human progress. The shuttle wasn't perfect, and we will make more such leaps as we are trying to do through our budget in 2011." That is my part, my insert. "But none of them will be perfect either." The programs on which we will embark under the guidance provided by President Obama in our proposed fiscal 2011 budget and his speech at the Kennedy Space Center of April 15th of this year will be our new leaps in human progress and they won't be perfect, but we must all understand and be incredibly proud that we have an opportunity to create an option for our children and grandchildren to live in a new and richer era of exploration. If we can agree to accept the promise that comes with the President's fiscal year 2011 budget proposal, we will be creating the future that we all wanted to see in the eras now passed.

The President has laid out the goals and strategies for this new vision which includes a sequence of deep-space destinations for human missions progressing step by step beginning with crewed flight tests early next decade of vehicles capable of supporting exploration beyond low-Earth orbit, a human mission to an asteroid by 2025 and a human mission to orbit Mars and return safely to Earth by the 2030s.

With respect to the role of heavy lift in the future human spaceflight architecture, the fiscal 2011 budget request includes funds for NASA to conduct the important R&D and analysis necessary to make an informed decision on a heavy-lift vehicle no later than 2015. On May 3rd, we issued a request for information seeking general information regarding potential launch or space transportation architectures that will be used for planning and acquisition strategy development for the current heavy-lift planning activities. And on May 19th, we issued a draft broad agency announcement that will expand on the previous NASA technical as-

sessments, address fiscal 2010 planned activities and also contribute to our future plans.

We have also made progress in developing a plan that supports the development of commercial crew transportation providers. On May 21st, we issued a request for information to seek industry feedback to help us plan the overall strategy for the development and demonstration of a commercial crew transportation capability and to receive comments on NASA's commercial human rating plan. The RFIs and BAAs are all preliminary planning activities for the President's fiscal year 2011 proposal regarding future human spaceflight efforts, and we appreciate that the Government Accountability Office's opinion issued on this past Monday confirming that NASA had not violated the exploration appropriations restriction on the use of funding to create or initiate new program or project activity.

Regarding our plans for a restructured Orion, the President directed that NASA build on the good work already completed on the Orion crew capsule and focus the efforts to provide a simpler and more efficient design, initially for crew emergency escape from the space station, evolving in future years to be the advanced spacecraft used in our deep-space missions. This approach will preserve a number of critical high-tech-industry jobs in key disciplines needed for our future deep-space exploration program. We have put together a formulation team including headquarters and center personnel to develop a baseline approach that meets these requirements balanced with the other priorities proposed in the President's fiscal 2011 budget request. The team will report to me next week on how best to meet these requirements.

And finally, on the subject of workforce transition initiatives, the President committed to providing \$40 million to aid Florida's Space Coast. The men and women who work in the Space Coast aerospace industry are some of the most talented and highly trained in the Nation. It is critical that their skills are tapped as we transform our country and grow the country's space exploration efforts. On May 3rd, the President established a taskforce to develop in collaboration with local stakeholders an interagency action plan to facilitate economic development strategies along the Space Coast and to provide training and other opportunities for affected aerospace workers. The taskforce, which I co-chair with Secretary of Commerce Gary Locke, will also explore future workforce and economic development activities that could be undertaken for affected aerospace communities in other States as appropriate.

NASA expects to submit a revised 2011 budget request to the Congress in the very near future that will identify funding requirements for the restructured Orion crew capsule as well as funding requirements for workforce transition.

Mr. Chairman, in conclusion, Americans and people worldwide have turned to NASA for inspiration throughout our history. Our work gives people an opportunity to imagine what is barely possible, and we at NASA get to turn these dreams into real achievements for all humankind. This budget gives NASA a roadmap to even more historic achievements as it spurs innovation, employs Americans in fulfilling jobs and engages people around the world as we enter an exciting new era in space.

Thank you very much for your continued support and that of this Committee. I look forward to responding to your questions.  
[The prepared statement of Mr. Bolden follows.]

PREPARED STATEMENT OF CHARLES BOLDEN, JR.

Chairman Gordon and Members of the Committee, thank you for the opportunity to appear today to discuss additional information about the President's FY 2011 budget request for NASA, following the President's important speech at the NASA Kennedy Space Center (KSC) in Florida. NASA is grateful for the support and guidance received from this Committee through the years and looks forward to working with you to implement the President's bold new direction for the Agency.

The President's FY 2011 budget request is good for NASA because it sets the Agency on a sustainable path that is tightly linked to our Nation's interests. The President recognizes that what is truly needed for beyond low-Earth orbit (LEO) exploration are game-changing technologies; making the fundamental investments that will provide the foundation for the next half-century of American leadership in space exploration. In doing so, the President has put forward what I believe to be the most authentically visionary policy for human space exploration that we have had since President Kennedy challenged NASA to send humans to the Moon and return them safely back to Earth. At the same time, under the new plan, we will ensure continuous American presence in space on the International Space Station (ISS) throughout this entire decade and likely beyond, re-establish a robust and competitive American launch industry, launch more robotic probes into our solar system as precursors for human activity, invest in a new heavy lift research and development (R&D) program, and build a technological foundation for sustainable, beyond-LEO exploration, with more capable expeditions in lunar space, and human missions to near-Earth asteroids, the Moon, Lagrange points, and, ultimately, Mars. NASA will embark on these transformative initiatives by partnering with the best in industry, academia and other government agencies, as well as with our international partners.

At the request of the Committee, today I will provide additional details about pending revisions to the President's FY 2011 budget request for NASA. I will discuss NASA's progress in developing plans for the new exploration initiatives included in the FY 2011 budget request, including initial planned program assignments for major programs by Center. Additionally, my testimony will provide additional detail about three significant updates that were announced by the President when he visited KSC on April 15, 2010. NASA is working expeditiously to provide specific budgetary details to reflect these updates and we will share them with this Committee and other Congressional stakeholders as soon as we are able.

**President Obama Visits KSC**

During his visit to KSC, the President articulated a strong commitment to NASA's mission and future U.S. human space exploration. The President also outlined an ambitious effort to foster the development of ground-breaking technologies; increase the number, scope, and pace of manned and unmanned space missions; make human spaceflight safer and more efficient; and help create thousands of new jobs. The President directed that NASA proceed to develop a crew rescue vehicle based on the Orion space-capsule to support emergency crew return requirements on the ISS, and providing a technological foundation for systems that can later take us beyond Earth's orbit. In addition to investing in transformative heavy-lift technologies, the President has called on NASA to select a basic rocket design, no later than 2015, and then begin to build it. The President also said that after decades of neglect, we will increase investment—right away—in other groundbreaking technologies that are designed to enable astronauts to reach space sooner and more often, to travel farther and faster for less cost, and to live and work in space for longer periods of time more safely. And, the President laid out the goals and strategies in this new vision for NASA. Fundamentally, the exploration of space will be a sequence of deep-space destinations for human missions matched to growing capabilities, progressing step-by-step, beginning with crewed flight tests—perhaps a circumlunar mission—early next decade of vehicles capable of supporting exploration beyond LEO, a human mission to an asteroid by 2025, and a human mission to orbit Mars and return safely to Earth by the 2030s. Finally, the President committed to providing \$40 million for workforce transition initiatives to aid Florida's Space Coast, and I have been appointed to co-Chair—along with Department of Commerce Secretary, Gary Locke—a task force to develop a strategy for assisting the workforce transition.

NASA expects to submit a revised FY 2011 budget request to the Congress in the near future that will identify funding requirements for the restructured Orion crew capsule as well as funding requirements and authorization for workforce transition for Florida and potentially other locations.

### **Restructuring the Orion Crew Capsule**

Per the President's direction, we are going to build on the good work already completed on the Orion crew capsule and focus the effort to provide a simpler and more efficient design that would provide crew emergency escape from the ISS and serve as part of the technical foundation for advanced spacecraft to be used in future deep space missions. This approach also will preserve a number of critical high-tech industry jobs in key disciplines needed for our future deep space exploration program.

We have put together a formulation team including Headquarters and Center personnel to develop a baseline approach that meets these requirements, balanced with the other priorities proposed in the President's FY 2011 budget request. This team will report to me next week on how best to meet these requirements.

I have directed the team to align this work so that it complements, and does not compete with, our commercial crew development effort. This should also reduce the pressure on the commercial crew service providers as the restructured Orion module serves to fulfill the important safety requirement of emergency escape for astronauts on the ISS. I have also directed the formulation team to focus on innovative approaches to oversight, and believe that we can significantly reduce oversight requirements based on lessons learned in previous focused development flight programs. We must accomplish this activity more efficiently and effectively to maintain a healthy funding balance across our exploration priorities. This will be done without reducing our commitment to safety for our NASA crews. The crew rescue mission has many fewer requirements than the deep space mission, providing design flexibility and reducing the system's lifecycle cost. Finally, the team must identify how this activity will align with the development efforts proposed in the Flagship Demonstration program as well as our other technology efforts so that investments in these programs can be leveraged to the greatest extent possible.

The funding for this restructuring will come from within NASA's top-line request released in February. The out year funding requirements will be refined as part of the President's FY 2012 budget submission.

### **Heavy-Lift Technologies**

During his visit to KSC, the President specifically recognized the need for a heavy lift launch capability to carry humans beyond LEO by requiring a decision on a vehicle design no later than 2015. Such a decision would include setting performance goals, identifying lift capability and selecting the general vehicle design—work that will ultimately lay the path for launching a spacecraft for crewed missions into deep space.

The FY 2011 budget request includes funds for NASA to conduct the important R&D and analysis necessary to make an informed decision on a heavy-lift vehicle no later than 2015. A primary focus of this effort will be to conduct research and development on a U.S. first-stage hydrocarbon engine for potential use in heavy lift and other launch systems, as well as basic research in areas such as new propellants, advanced propulsion materials manufacturing techniques, combustion processes, propellant storage and control, and engine health monitoring. Additionally, NASA will initiate development and testing of in-space engines. Areas of focus could include a liquid oxygen/methane engine and lower-cost liquid oxygen/liquid hydrogen engines. This work will build on NASA's recent R&D experience in this area, and the test articles will be viewed as a potential prototype for a subsequent operational engine that would be re-startable and capable of high acceleration and reliability. These technologies will increase our heavy-lift and other space propulsion capabilities and is intended to significantly lower costs—with the clear goal of taking us farther and faster into space consistent with safety and mission success criteria. In support of this initiative, NASA will explore cooperative efforts with the Department of Defense and also develop a competitive process for allocating a small portion of these funds to universities and other non-governmental organizations. This research effort along with many of our new technology initiatives will be coordinated with the broader Agency technology initiative led by NASA's new Chief Technologist.

On May 3, 2010, NASA issued a Request for Information (RFI) seeking general information regarding potential launch or space transportation architectures (expandable, reusable, or a hybrid system) that could be utilized by multiple customers (e.g., NASA, commercial and other Government agencies). The RFI solicits informa-

tion regarding propulsion system characteristics; technology challenges for propulsion systems; as well as innovative methods to manage a heavy-lift development program to include effective and affordable business practices. The RFI is open to the broad space community, including commercial, other Government agencies and academia. Information obtained from the RFI will be used for planning and acquisition-strategy development for current heavy-lift planning activities, funded in the FY 2010 Consolidated Appropriations Act (P.L. 111-117). Related to the RFI, on May 19, 2010, NASA posted a *draft* Broad Area Announcement (BAA). This draft BAA is soliciting proposals for a Heavy Lift and Propulsion Technology Trade study and seeks industry input on technical solutions in support of heavy lift system concepts studies. This draft BAA requests offerors to expand upon the previous NASA technical assessments and a final BAA solicitation will incorporate information obtained via the RFI as well as inputs from the upcoming Exploration workshop. These concept studies will include architecture assessments of a variety of potential heavy lift launch vehicles and in-space vehicle architectures employing various propulsion combinations and how they can be deployed to meet multiple mission objectives. Please note, the BAA is addressing FY 2010 planned activities which may also contribute to future plans and activities.

#### **Assistance for the Florida Space Coast**

The men and women who work in the Space Coast's aerospace industry are some of the most talented and highly trained in the nation. It is critical that their skills are tapped as we transform and grow the country's space exploration efforts. The 2004 decision to end the Shuttle means that approximately 6,000 jobs need to be transitioned into the new space strategy and related industries. Recognizing the concerns of our dedicated Shuttle workforce as they conclude this remarkable program and look forward to transitioning to new work, the President has announced a \$40 million initiative to develop a plan for regional economic growth and job creation for the Florida Space Coast. On May 3, 2010, the President issued a Memorandum directing the establishment of the *Task Force on Space Industry Workforce and Economic Development*. The task force is charged with developing, in collaboration with local stakeholders, an interagency action plan to facilitate economic development strategies and plans along the Space Coast and to provide training and other opportunities for affected aerospace workers so they are equipped to contribute to new developments in America's space program and related industries. They will also explore future workforce and economic development activities that could be undertaken for affected aerospace communities in other States, as appropriate. The Secretary of Commerce and I will serve as Co-Chairs. Other team members will include: the Secretary of Defense; the Secretary of Labor; the Secretary of Housing and Urban Development; the Secretary of Transportation; the Secretary of Education, the Chair of the Council of Economic Advisors; the Director of the Office of Management and Budget; the Administrator of the Small Business Administration; the Director of National Intelligence; the Director of the Office of Science and Technology Policy; the Director of the National Economic Council; and the heads of other Executive agencies, as needed. As directed, the team will report its recommendations to the President by August 15. The \$40 million for this initiative will be taken from the funds requested for Constellation transition in the original FY 2011 Presidential budget request.

This interagency group's recommendations will build on the Administration's ongoing efforts in the KSC region. The Department of Labor is already planning a pilot program to better assist the region's workers, including those highly-skilled workers who work in the aerospace industry, through efforts to establish one-stop local transition centers for affected workers where they can receive coordinated local, state, and Federal workforce assistance tied to economic development efforts; and the designation of a single Federal point-of-contact for affected areas.

To further facilitate these efforts, the Department of Commerce's Economic Development Administration (EDA) is prepared to support a comprehensive economic adjustment strategy for the Kennedy Space Center economic region. With funding provided through NASA, the EDA will provide both financial and technical assistance to start implementing those plans and promote economic development in the region through such activities as infrastructure upgrades and improvements, entrepreneurial networks, and skill-training facilities and equipment. The exact mix of activities will depend on the recommendations and request of local entities across the region.

In addition, on April 30, 2010, the Department of Labor announced a \$1.2 million grant to assist approximately 200 workers affected by layoffs at ATK Launch systems in Corinne, Utah, in connection with the transition of the Space Shuttle and Constellation programs.

### **NASA Prepares to Implement the FY 2011 Budget Request**

Pursuant to the President's proposed new course, NASA has initiated planning activities to be able to effectively and efficiently implement these new activities in a timely manner upon Congressional enactment of the FY 2011 budget. In April, NASA outlined for the Committee the Agency's planned major program assignments across the Agency's Centers for new or extended activities proposed as part of the President's FY 2011 budget request. These planned assignments build on the deep knowledge and expertise that NASA has built up over five decades, recognize the wealth of experience, commitment, and expertise resident at the NASA Centers, and expand upon the strengths at each Center.

I wish to emphasize that establishment of program offices and initiation of effort in support of new or extended activities for this proposed new work is contingent upon Congressional approval of the President's FY 2011 request for these activities. These planned program assignments will enable NASA to engage workforce at the Agency's Centers in formulation activities for the array of program initiatives in Science, Aeronautics, Space Technology, Exploration, and Space Operations reflected in the President's FY 2011 request. While we will be developing details on the specific numbers of employees at our Centers that will be assigned to new program offices and activities, these planned assignments are intended to provide the Committee additional detail regarding the depth and scope of the President's FY 2011 proposed budget plan.

Planned major program assignments for elements contained in the FY 2011 budget, by Center, follow:

- Johnson Space Center, Texas
  - Exploration/Flagship Technology Demonstrations, Manager
  - Exploration/Commercial Crew Development, Deputy Program Manager
  - Exploration/Commercial Cargo Development, Manager
  - Exploration/Human Research, Manager
  - ISS, Manager
- Kennedy Space Center, Florida
  - Exploration/Commercial Crew Development, Manager
  - Space Operations/21st Century Launch Complex, Manager
  - Exploration/Flagship Technology Demonstrations, Deputy Program Manager
  - Space Shuttle/Completion of Manifest, Manager
- Marshall Space Flight Center, Alabama
  - Exploration/Heavy Lift and Propulsion R&D, Manager
  - Exploration/Robotic Precursor Program, Manager
  - Space Technology/Crosscutting Capability Demonstrations/Technology Demonstration Missions, Manager
  - Space Technology/Centennial Challenges Program, Manager
- Stennis Space Center, Mississippi
  - Exploration/Heavy Lift and Propulsion R&D, First Stage and Upper Stage Rocket Testing
  - Exploration/Commercial Crew Development, Engine Testing for Commercial Vehicles
- Glenn Research Center, Ohio
  - Exploration/Exploration Technology Development and Demonstration, Manager
  - Space Technology/Early Stage Innovation/Research Grants
  - Aeronautics Research/Integrated Systems Research Program and Aviation Safety Program, support
- Langley Research Center, Virginia
  - Space Technology/Game Changing Technology/Game Changing Development, Manager
  - Climate Initiative: SAGE III; CLARREO (managed jointly with Goddard); Venture Class
  - Aeronautics Research/Integrated Systems Research Program and Aviation Safety Program, support
- Dryden Flight Research Center, California

- Space Technology/Crosscutting Capability Demonstrations/Flight Opportunities, Manager
- Aeronautics Research/Integrated Systems Research Program and Aviation Safety Program, support
- Ames Research Center, California
  - Exploration/Precursor Robotic Missions/Exploration Scouts, Manager
  - Space Technology/Game Changing Technology/Small Satellite Subsystem Technologies, Manager
  - Space Technology/Crosscutting Capability Demonstrations/Edison Small Satellite Demonstrations, Manager
  - Aeronautics Research/Integrated Systems Research Program and Aviation Safety Program, support
- Goddard Space Flight Center, Maryland
  - Joint Polar Satellite System (restructuring NPOESS), procurement structure modeled after past successful programs
  - Climate Initiative: ICESat-2; CLARREO (managed jointly with Langley); DESDynI (managed jointly with Jet Propulsion Laboratory); Earth Systematic Missions Program.
- Jet Propulsion Laboratory, California
  - Climate Initiative: SMAP; DESDynI (managed jointly with Goddard); GRACE, OCO-2.

Following the release of the FY 2011 budget request, NASA established study teams within the Exploration Systems Mission Directorate (ESMD) to ensure we understand the steps (and the implications of those steps) that would need to be taken for an orderly transition of the Constellation Program and to plan for the implementation of the new initiatives in the Exploration program. The work undertaken by these teams is a necessary part of that planning. Following is a brief summary of the additional details developed for each initiative, as “point of departure” plans to support FY 2011 budget implementation, once the budget is approved. Please note these are preliminary ESMD plans that may need to be modified following finalization of Agency plans regarding the restructuring of the Orion crew capsule.

- **Flagship Technology Demonstrations:** The next generation of capabilities key to sustainably exploring deep space will be demonstrated through four proposed missions: advanced space propulsion in 2014, in-space propellant and fuel transfer in 2015, light weight/inflatable modules in 2016, and aerassist in 2017. Autonomous operations and advanced life support capabilities will also be tested on these missions. Detailed definition of each mission’s content is currently under way.
- **Heavy Lift and Propulsion Technology:** Planned technology investments will lead to a demonstration of an in-space engine in 2015, development of a First Stage propulsion system by 2020, and maturing other foundational propulsion technologies to support a heavy lift vehicle decision in the 2015 timeframe. NASA’s efforts will be primarily focused on a LOX/RP first stage and either a LOX/methane or LOX/hydrogen in-space engine. Additional research will be dedicated to analysis and trades regarding fuel types, performance requirements, and vehicle architectures.
- **Exploration Robotic Precursors:** A series of annual exploration robotic precursor missions is being planned, beginning with launch of a Near-Earth-Orbit (NEO) mission in 2014, followed by a lunar lander in 2015, and two Mars missions in 2016 and 2018, respectively. In addition, smaller robotic scout missions will be launched every 12–18 months to support reconnaissance, evaluate hazards, and develop systems and operations in support of future human exploration.
- **Enabling Technology Development and Demonstration:** Enabling technology will advance fundamental technologies in 10 portfolio areas that will lead to ground and flight demonstrations in lunar volatiles, high power electric propulsion, autonomous precision landing, human exploration tele-robotics, fission power systems, and other areas. The flight demonstrations will be done as part of flagship demonstrations, robotic precursor missions, or utilizing the ISS, ground tests and analogs.
- **Human Research:** Through research and technology development, the goal of the Human Research Program is to reduce the highest risks to crew health and performance for space exploration missions. Increased investments will

be made in the fields of biomedical technology, space radiation research, and behavioral health research. There are also plans to make increased use of the ISS facilities.

- **Commercial Crew:** NASA is continuing to define plans to expedite and improve the robustness of ISS crew and cargo delivery. In addition, NASA is developing a plan that supports the development of commercial crew transportation providers to whom NASA could competitively award crew transportation services. Solicitations for Commercial Crew Transportation (CCT) development will provide opportunities for both established and traditional aerospace companies as well as emerging entrepreneurial companies. Related to this activity, on May 21, NASA released a Request for Information to seek industry feedback to help the Agency plan the overall strategy for the development and demonstration of a CCT capability and to receive comments on the Commercial Human-Rating Plan that has been drafted as part of this initiative.
- **Constellation Transition:** The team is leveraging expertise from across the Agency to develop a rapid and cost effective ramp-down plan that will free the resources required for new programs. As part of the early characterization and integrated planning effort, this team has initiated a broad survey of current workforce, contracts, facilities, property, security, knowledge capture, information technology, and other government agency interface issues to determine what infrastructure and hardware could be used by the new programs and projects. The transition plan will outline three phases as part of an action plan for initial deliverables: Near-term actions, transitioning of Constellation elements, and transition of assets/resources to new Exploration focus areas and other NASA programs, where appropriate.

NASA is taking prudent steps to *plan* for the new initiatives included in the FY 2011 budget request, including Requests for Information (RFI), workshops, and preliminary studies. NASA is eager to receive external input from industry, academia, and other partners, and is accomplishing this via a series of RFIs and industry workshops conducted this spring and into the summer. Doing so will ensure that NASA receives important feedback from our space partners before it begins to finalize its implementation plans for the new technology demonstrations and human spaceflight systems development activities that will be supported by the FY 2011 budget, once approved by Congress. During CY 2010, NASA plans to issue a series of program formulation documents seeking input from the broader space community. The following are tentative timeframes for these activities:

- **Flagship Technology Demonstrations:** RFI issued May 17, 2010.
- **Heavy Lift and Propulsion Technology:** RFI issued May 3, 2010; Broad Agency Announcement (BAA) posted on May 19.
- **Exploration Robotic Precursor Missions:** RFI issued May 21, 2010.
- **Enabling Technology Development:** RFI issued May 7, 2010; BAA in June/July.
- **Human Research Program:** BAA in July.
- **Commercial Crew Transportation:** RFI issued May 21, 2010.

The first major public discussions about NASA's FY 2011 planned activities are occurring at a two-day Exploration Enterprise Workshop, which started yesterday and will conclude today in Galveston, Texas. The workshop is bringing together a broad community of stakeholders from industry, academia, and the Federal Government to engage in discussions related to strategy building, development, and the implementation of the new plans for human and robotic exploration in space.

The workshop is focusing on the President's FY 11 budget request for NASA Exploration. The Agency has completed the initial phase of planning for the new technology and robotic programs and is providing insight into progress to date. The objectives of the workshop are to:

- Describe and discuss the activities planned for inclusion in the new programs
- Discuss NASA Center proposed Program assignments
- Solicit feedback, ideas and suggestions from interested parties
- Prepare for the next steps once the new programs are implemented

In addition, NASA has also established study teams to plan for the implementation of the new initiatives related to the ISS Augmentation, 21st Century Space Complex and Space Technology. Additional information on these planning efforts as well as planned RFIs, workshops, and preliminary studies are outlined below.

- **ISS Augmentation:** The ISS program is reviewing functionality enhancements that will make the space station more capable and efficient, including: upgraded environmental systems and communications, techniques for saving space and improving the use of pressurized volume, tools for optimizing flight and ground-crew time, upgrading and expanding payload operations, enhancing EVA and robotics use on Station, and reducing the complexity of international interfaces.
  - NASA will initiate an independent organization, as recommended by the Augustine Committee and the National Research Council that will support the space station research community.
- **21st Century Space Launch Complex:** NASA has developed a list of potential project ideas with preliminary estimates to be used as one potential source of solutions to customer needs as they are identified. These initial focus areas will be adjusted as customer needs are better understood: 1) Expanding capabilities to support commercial launch providers; 2) Environmental remediation; 3) Enhancing payload processing capabilities; and, 4) Supporting the modernization of the launch range capabilities.
  - In late May, NASA will release an RFI to get a first-hand understanding of investments that would be most useful in support of launch and related activities in order to help the Agency prioritize near-term projects.
- **Space Technology:** NASA's Space Technology initiative under the Office of the Chief Technologist (OCT) will develop and demonstrate advanced space systems concepts and technologies enabling new approaches to enhance NASA's current mission set and enable future missions. Planning teams continue to make significant progress: an internal technology governance plan has been approved; an Agency-level technology road mapping activity is planned to begin in July; and, approved technology program plans for Early Stage Innovation, Game Changing Technology, and Crosscutting Capability Demonstrations will be completed by the end of June.
  - NASA will issue a Crosscutting Capability Demonstrations RFI in June 2010. Game Changing Technology Industry Day will occur in late June 2010. Early Stage Innovation NASA Research Announcements (NRA's) are targeted for late June 2010. An RFI soliciting potential topics for the proposed Space Technology Graduate Fellowship program has been released to the NASA Centers and Federal Research Laboratories.

Finally, NASA has established the Human Exploration Framework Team (HEFT) to serve as a crossAgency planning activity. The team is being led by the Exploration Systems Mission Directorate and staffed with technical leaders from across NASA Centers. The team is focused on developing and reviewing the integrated set of requirements and technologies required for future human spaceflight missions to many destinations, including Mars. As part of its broad integration charter, HEFT will develop implementation recommendations on the performance and pacing requirements for the technologies needed for future human exploration missions using "design reference missions," or DRMs. These DRMs will be the basis for validating capabilities and missions for 5-, 10-, and 15-year horizons, with milestones including crewed missions beyond the Moon into deep space by 2025, sending astronauts to an asteroid, and eventually landing on Mars. NASA expects to have initial products from the HEFT team this summer.

#### **Extension and Enhanced Use of the International Space Station**

A key element of America's future in space is the ISS that is due to be completed this year. As of May 2009, the ISS is able to support a six-person permanent crew. The three major science labs aboard ISS were completed in 2009 with the delivery of the Exposed Facility of the Japanese Kibo module. And last week, Space Shuttle Atlantis delivered science experiments and a new Russian laboratory to the ISS, continuing the transition from assembly to continuous scientific research through the end of the decade. The Russian-built Mini Research Module-1, also known as Rassvet (dawn in Russian), will host a variety of biotechnology, biological science, fluid physics and educational research experiments. Rassvet was attached to the bottom port of the ISS's Zarya module on May 18.

The ISS represents a unique research capability which the United States and its partner nations can use to conduct a wide variety of research in biology, chemistry, physics and engineering fields that will help us better understand how to keep astronauts healthy and productive on long-duration space missions. If Congress approves the FY 2011 budget request, NASA will be able to fully utilize the ISS and increase its capabilities through upgrades to both ground support and onboard sys-

tems. Importantly, this budget extends operations of the ISS, likely to 2020 or beyond.

ISS research is anticipated to have terrestrial applications in areas such as biotechnology, bioengineering, medicine and therapeutic treatment. The FY 2011 budget request for ISS reflects increased funding to support the ISS as a National Laboratory in which this latter type of research can be conducted. NASA has two MOUs with other U.S. government agencies, and five agreements with non-government organizations to conduct research aboard the ISS. NASA intends to continue to expand the community of National Laboratory users of the ISS.

ISS can also play a key role in the technology demonstrations and engineering research associated with exploration. Propellant storage and transfer, life support systems, and inflatable technology can all benefit by using the unique research capabilities of ISS. In addition to supporting a variety of research and development efforts, the ISS will serve as an incubator for the growth of the low-Earth orbit space economy.

As a tool for expanding knowledge of the world around us; advancing technology; serving as an impetus for the development of the commercial space sector; demonstrating the feasibility of a complex, long-term, international effort; providing critical data regarding human long duration spaceflight; and, perhaps most importantly, inspiring the next generation to pursue careers in science, technology, engineering, and mathematics, the ISS is without equal.

### Conclusion

Americans and people worldwide have turned to NASA for inspiration throughout our history—our work gives people an opportunity to imagine what is barely possible, and we at NASA get to turn those dreams into real achievements for all humankind. This budget gives NASA a roadmap to even more historic achievements as it spurs innovation, employs Americans in fulfilling jobs, and engages people around the world as we enter an exciting new era in space. NASA looks forward to working with the Committee on implementation of the FY 2011 budget request.

Chairman Gordon, thank you for your support and that of this Committee. I would be pleased to respond to any questions you or the other Members of the Committee may have.

### BIOGRAPHY FOR CHARLES BOLDEN, JR.



Nominated by President Barack Obama and confirmed by the U.S. Senate, retired Marine Corps Maj. Gen. Charles Frank Bolden, Jr., began his duties as the twelfth Administrator of the National Aeronautics and Space Administration on July 17, 2009. As Administrator, he leads the NASA team and manages its resources to advance the agency's missions and goals.

Bolden's confirmation marks the beginning of his second stint with the nation's space agency. His 34-year career with the Marine Corps included 14 years as a member of NASA's Astronaut Office. After joining the office in 1980, he traveled to orbit four times aboard the space shuttle between 1986 and 1994, commanding two of the missions. His flights included deployment of the Hubble Space Telescope and the first joint U.S.-Russian shuttle mission, which featured a cosmonaut as a mem-

ber of his crew. Prior to Bolden's nomination for the NASA Administrator's job, he was employed as the Chief Executive Officer of JACKandPANTHER LLC, a small business enterprise providing leadership, military and aerospace consulting, and motivational speaking.

A resident of Houston, Bolden was born Aug. 19, 1946, in Columbia, S.C. He graduated from C. A. Johnson High School in 1964 and received an appointment to the U.S. Naval Academy. Bolden earned a bachelor of science degree in electrical science in 1968 and was commissioned as a second lieutenant in the Marine Corps. After completing flight training in 1970, he became a naval aviator. Bolden flew more than 100 combat missions in North and South Vietnam, Laos, and Cambodia, while stationed in Namphong, Thailand, from 1972–1973.

After returning to the U.S., Bolden served in a variety of positions in the Marine Corps in California and earned a master of science degree in systems management from the University of Southern California in 1977. Following graduation, he was assigned to the Naval Test Pilot School at Patuxent River, Md., and completed his training in 1979. While working at the Naval Air Test Center's Systems Engineering and Strike Aircraft Test Directorates, he tested a variety of ground attack aircraft until his selection as an astronaut candidate in 1980.

Bolden's NASA astronaut career included technical assignments as the Astronaut Office Safety Officer; Technical Assistant to the director of Flight Crew Operations; Special Assistant to the Director of the Johnson Space Center; Chief of the Safety Division at Johnson (overseeing safety efforts for the return to flight after the 1986 Challenger accident); lead astronaut for vehicle test and checkout at the Kennedy Space Center; and Assistant Deputy Administrator at NASA Headquarters. After his final space shuttle flight in 1994, he left the agency to return to active duty the operating forces in the Marine Corps as the Deputy Commandant of Midshipmen at the U.S. Naval Academy.

Bolden was assigned as the Deputy Commanding General of the 1st Marine Expeditionary Force in the Pacific in 1997. During the first half of 1998, he served as Commanding General of the 1st Marine Expeditionary Force Forward in support of Operation Desert Thunder in Kuwait. Bolden was promoted to his final rank of major general in July 1998 and named Deputy Commander of U.S. Forces in Japan. He later served as the Commanding General of the 3rd Marine Aircraft Wing at Marine Corps Air Station Miramar in San Diego, Calif., from 2000 until 2002, before retiring from the Marine Corps in 2003. Bolden's many military decorations include the Defense Superior Service Medal and the Distinguished Flying Cross. He was inducted into the U.S. Astronaut Hall of Fame in May 2006.

Bolden is married to the former Alexis (Jackie) Walker of Columbia, S.C. The couple has two children: Anthony Che, a lieutenant colonel in the Marine Corps who is married to the former Penelope McDougal of Sydney, Australia, and Kelly Michelle, a medical doctor now serving a fellowship in plastic surgery.

Chairman GORDON. Thank you, Administrator Bolden.

If there are members who wish to submit additional opening statements, your statement will be added to the record at this time.

[The prepared statement of Ms. Giffords follows:]

PREPARED STATEMENT OF REPRESENTATIVE GABRIELLE GIFFORDS

Today's hearing is one of the most important that this Committee will hold this year. We will be deliberating on the future of America's human spaceflight program, and in essence we will be deliberating about the future of this great country. The stakes are that high.

As Chair of the Space and Aeronautics Subcommittee, I have been working since last year to hold hearings and to conduct oversight to illuminate the issues that need to be considered if we are to craft a human exploration program that can be successful and worth undertaking.

There were a number of themes that recurred throughout all of those hearings and oversight activities: the need for budgets that are adequate for the tasks to be undertaken—you can't do meaningful exploration "on the cheap"; the need to sustain a commitment and not keep constantly changing direction or goals; the need to keep safety paramount and not assume that it will be maintained without diligent effort and hard work; and the need to examine the broader national and international context when contemplating any changes to programs.

I had hoped that the Administration's FY 2011 budget request would reflect those themes. Unfortunately, it does not. Not only does the Administration's plan not provide a budget plan that would help redress the balance between what NASA is asked to do and what it has been provided to date, but it has all the hallmarks of

an ill-conceived mishmash of buzzwords about innovation and inspiration, assumptions based on hope rather than data, and an apparent desire to discard all of the work carried out by the previous Administration.

We are now seeing the consequences of that approach. Nearly four months after the initial rollout of the budget and after an addendum by the president on April 15th, Congress still is unable to get answers to basic questions about the proposed plan. Even something as basic as asking how the Administration intends to pay for the crew rescue vehicle development program that was added to NASA's budget without any additional funding is beyond their capacity to answer.

In that case, I think the reason for their unwillingness to answer is clear: the needed funding will have to come out of the "technology and innovation" initiatives that they touted as hallmarks of their new approach. In short, those new investments that were to compensate Centers for the loss of their work on Constellation are illusory and always were. I will not dwell on the other contradictions and shortcomings of the plan in these brief remarks—I believe that the distinguished witnesses we have here today will be able to articulate them quite clearly on their own.

What I do want to emphasize is that we are now at the point where the lack of a credible plan from the Administration means that Congress is going to have consider alternative options that will provide a productive path forward for our human space flight program. We may not be able to correct for all the past underfunding in a single authorization or appropriation bill, nor can we negate the past actions that will lead us to a "gap" in crewed access to space after the Shuttle is retired. Yet we can make a start, and at a minimum, we can start by heeding the wisdom contained in the classic dictum: "first do no harm". I believe that we would do irreparable harm to our nation's human space flight program if we were to adopt the Administration's proposals. I intend to work to ensure that we take a better path.

[The prepared statement of Mr. Costello follows:]

PREPARED STATEMENT OF REPRESENTATIVE JERRY F. COSTELLO

Good Morning. Thank you, Mr. Chairman, for holding today's hearing to receive testimony on the National Aeronautics and Space Administration (NASA) human spaceflight plan proposed in the President's Fiscal Year 2011 budget.

The President's budget is a general departure from the *NASA Authorization Act of 2008* passed by Congress and signed into law. It proposes major changes to NASA's human spaceflight program, including a shift to commercial crew vehicles, a termination of the Constellation Program, and the elimination of the moon as the next destination for NASA's astronauts. In the past three months, these plans and goals rapidly have changed and developed, but I am concerned there has been limited communication between Congress and the administration to address concerns with the budget and ensure these changes will maintain our leadership in human spaceflight for generations to come.

First, the end of Constellation will result in the loss of tens of thousands of jobs at NASA and the companies with whom NASA has contracted out work. With the budget's strong investment in commercial human spaceflight over government-operated programs, there is a chance these jobs could disappear all together. However, according to NASA, commercial crew vehicles will create tens of thousands of jobs and through new, commercial contracts many of these workers will return to their jobs. I would like to hear from our witnesses what impact they believe a shift to commercial crew vehicles will have on the aerospace workforce.

Second, on April 15, 2010, the President announced several changes to his initial FY 11 budget, including identifying destinations for human spaceflight by 2025 and reinstating NASA's investment in the design and possible construction of a Heavy Lift Launch Vehicle. However, no additional funding was provided for NASA to achieve these new goals. In fact, the proposed budget and the outyear projections fall short of the Augustine Commission's recommended budget increases to achieve meaningful developments in human spaceflight. I am interested in hearing how the President's new goals and the underlying FY 11 human spaceflight plans may fall within the proposed \$19 billion budget. If the plans will require additional funding or offsets, what steps will NASA take to ensure it stays on schedule and within the budget for these new plans.

Third, the President's budget makes major investments in research and development within NASA. I strongly support these efforts to develop cutting-edge technology and expand NASA's discoveries beyond space to address everyday national challenges. However, a recent report from the National Research Council found that NASA's laboratories and flight centers were inadequate and could fail to perform the research tasks presented by the FY 11 budget. I would like to hear from Admin-

istrator Bolden what plans are in place or proposed to address these inadequacies and ensure NASA can carry out its research mission.

Finally, Congress and the administration must have an open dialogue to hear determine all aspects of NASA's proposed budget. Without these clear lines of communication, we cannot make an informed decision about the direction NASA should take with the future of human spaceflight.

Thank you again, Mr. Chairman.

Chairman GORDON. We will now start our questions, and the Chair yields to himself for the first question.

Administrator Bolden, you have heard the concerns I raised in my opening statement, a budget that falls below what the Augustine Committee said would be needed for a viable program, the addition of an unfunded crew rescue vehicle program that will put additional stress on the budget, and the lack of someone would call credible cost estimates from the commercial crew initiative that could wind up adding even more stress. Any one of these would be a warning flag, but we have three here, and so make me feel better that this budget will accomplish the mission that you have set forth.

#### FEASIBILITY OF NEW BUDGET

Mr. BOLDEN. Mr. Chairman, very simply, what this budget does, is it provides funding for research and development, rejuvenation of those activities, whether it is on college and university campuses or whether in industry itself. It also provides us with a way to increase the amount that we contribute to technology development that will be absolutely necessary if we are going to go beyond low-Earth orbit. What makes this budget different and what makes our program, our evolving different from the past is that we are going to take incremental steps to leave low-Earth orbit. It is absolutely necessary that I facilitate the success of commercial entities to continue to get me to low-Earth orbit because I need the International Space Station over the coming ten years and hopefully beyond because that plays an important role in the development of the technologies that will be required to get us beyond low-Earth orbit. Very simply, the steps are International Space Station, moon and asteroids and eventually to Mars in the 2030s.

In terms of technology development, new engine technology, new structures technology, composites that give us lighter-weight vehicles that require less stress to leave the gravity well of Earth that will take us to eventually a heavy-lift launch vehicle by the 2020s, in-space propulsion development that will get us beyond low-Earth orbit. And then finally, the Crew Rescue Vehicle development that the President has authorized me to do that will lead to the development of a deep-space exploration crew module. Crew Rescue Vehicle, while maybe not the ideal thing that we would all like, it gives me a phase-zero vehicle that I can use as the technological foundation for building the crew module that I need to get humans beyond low-Earth orbit.

Chairman GORDON. Are you satisfied that the budget you have presented us will fund the crew rescue vehicle including all the other things that you have done and that—so you are satisfied where you are now?

Mr. BOLDEN. Mr. Chairman, I am satisfied in one respect. I am cognizant of the difficulty of the fiscal environment in which we all

live, and as you and I have said, as a responsible steward of the taxpayers' funds, I understand that I will have to find offsets that will enable us to speed up the development of a heavy-lift launch vehicle.

#### FUNDING A CREW RESCUE VEHICLE

Chairman GORDON. Do you want to suggest some of those today?

Mr. BOLDEN. Sir, I can tell you things that I am not going to take off the table, and you and I have discussed this. Aeronautics and science, they are not available for offsets.

Chairman GORDON. But what does that leave?

Mr. BOLDEN. It leaves commercial crew and it leaves some of my technology development, and I actually think that with prudent planning, we can plan what we need to take out of the funds that are available for—that the President has set aside for commercial crew and we can take some of the funds that I would like to spend up front for technology development, put money into those things that I absolutely have to have for heavy-lift launch vehicle.

Chairman GORDON. And when do you plan to present to us—we would like to help you with an authorization but we have to see your plan, we have to see your numbers before we can do that. And we would like for them to add up.

Mr. BOLDEN. And I assure you, Mr. Chairman, they will add up. The amount for the crew return vehicle, we actually have refined that and I think it is going to end up being about \$4.5 billion, so I am going to have to find a place within commercial crew and technology development where I can—

Chairman GORDON. When do you expect to present that to us?

Mr. BOLDEN. Mr. Chairman, I am hoping to refine my numbers by next week and I will get them to you as soon as I can, as I promised yesterday. I do not want to give you a date certain and disappoint you and me.

Chairman GORDON. Well, again, I don't want to belabor this. As I have said before and I said to you, part of the problem, we are in this situation because the Constellation quite frankly for the last several years wasn't funded properly, and kept kicking those bills down the road. You inherited them. And so I do not want to start that process over again of just kicking it down the road until your successor or you have to then really bite the bullet and then we say, you know, we have wasted these additional dollars. We have been through this with National Polar-orbiting Operational Environmental Satellite System, we have been through this with the older Constellation program. So I won't belabor. I look forward to getting that from you and having a constructive discussion about it, and I yield to the ranking member, Mr. Hall.

Mr. HALL. Mr. Chairman, I thank you.

I don't mind belaboring it a little bit, and Charlie, you know my respect for you, but when I hear going to find something or maybe next week, you need to be a little more—you know, senior NASA program officials in an on-the-record meeting with Committee staff stated that the cost of developing an Orion-style crew rescue vehicle would be on the order of \$5 billion to \$7 billion, and we discussed that figure yesterday. You were kind enough to talk to us and give us that information. But word from NASA's fiscal year

2011 budget, you plan to pay for the capability. Will it come from within the exploration program budget or will the science and aeronautics research directorates be taxed as well? And as a follow-up question, does NASA hope to have the—when do they hope to have the crew rescue vehicle ready for use as an emergency lifeboat on the International Space Station?

Mr. BOLDEN. Representative Hall, my hope is to have the first version of Orion available by 2013 to 2015. It is a challenge but I think we can do that. The one thing that I can promise you and everybody on this Committee is that when we do bring you our budget numbers, you will not see bumps above the curve. Nineteen billion is my budget for this coming year, and what I do not want to do, as Chairman Gordon has said, I don't want to bring you an unexecutable budget and I will not bring you an unexecutable budget, so everything will be below the curve, and I can do that. My people can do that and we are going to do it. I admit, we are late. We started out late. But we are trying to catch up.

I hate to quote—well, I don't hate to quote it, but I love quoting my predecessor, Mike Griffin. I read something that he wrote in a book that we are dedicating to the shuttle when he was talking about how, you know, you make decisions. He said, "Late is ugly until you launch. Wrong is ugly forever." And so I do not want to give you something that is wrong and I won't give you something that is wrong. I do apologize for it being late but it is going to be right so that we don't—you know, because we are going to have to live with it.

Mr. HALL. The crew rescue vehicle, that fund, the \$5 billion to \$7 billion, is not to be mixed nor funding the escape system. That is correct, isn't it?

Mr. BOLDEN. Congressman, one of the ways that we are going to reduce the cost on what is called the crew rescue vehicle—and I will be honest, I don't like that term. I wish we hadn't used it, but we did. The crew rescue vehicle initially, the phase-zero vehicle to which I refer, will not be rated for ascent for humans. We will take it to orbit without people in it, dock it to the International Space Station and so it takes away the requirement for a launch abort system, which is a—

Mr. HALL. That answers a different question. Actually the crew escape system is not to be funded by this \$5 to \$7 billion, is it?

Mr. BOLDEN. Oh, I am sorry. You are correct, sir.

Mr. HALL. And you say that you are going to be working and you are going to watch it, but as you watch it, you watch it with no people in it. It gives us little access, I think, to getting back to the success of the old days.

Mr. BOLDEN. Congressman, we will have no people in it when it goes to orbit because that would increase the cost up front to human-rated for—

Mr. HALL. Who would pay that cost?

Mr. BOLDEN. I am sorry, sir?

Mr. HALL. Who would pay that cost up front?

Mr. BOLDEN. There will be no upfront cost for human rating because we are not going to do that initially. The phase-zero vehicle will not be human rated for ascent. It will be human rated for—it will comply with our visiting vehicle requirements in order to be

docked to the International Space Station for a period of anywhere from six months to a year, and then it will be human rated for descent, entry and landing, so that is part of the incremental steps that I talk about.

Mr. HALL. I have some more questions but I am about to run out of my time to even say I am about to run out of my time, but lack of a fallback option if the commercial crew fails is something that really concerns me, that anybody can take over something but we need some assurance that you are not just going to take it over but you are going to complete it, and if they fall down or falter they are not going to turn back and hand us a broken pattern to try to fill out where if we stay with where we are going and what Republicans and Democrats alike have voted for for the last five or six or seven years, it seems that would be the most likely and the best way to solve and keep our international partners, keep that great workforce that we have got in place right now that we are going to lose. I know you put all that into the computer. Maybe I will get to talk to you about it a little more. Thank you, Charlie.

Mr. BOLDEN. Thank you very much.

Chairman GORDON. Thank you, Mr. Chairman. I suspect you are going to have a chance to talk to him a lot more about that and other things.

Ms. Fudge is recognized.

#### GLENN RESEARCH CENTER

Ms. FUDGE. Thank you, Mr. Chairman, and thank you, Administrator Bolden. It is nice to see you again. As you know, I represent northeast Ohio.

Mr. BOLDEN. Yes, ma'am.

Ms. FUDGE. Which is home to NASA Glenn.

Mr. BOLDEN. Yes, ma'am.

Ms. FUDGE. So of course, one of my main priorities is what is going to happen with NASA Glenn.

Mr. BOLDEN. Yes, ma'am.

Ms. FUDGE. I feel that in much of the discussion around the future of human space exploration, research centers like Glenn have not received the same kind of consideration as other NASA centers. While I understand that spaceflight centers will be significantly impacted by the plan, the truth is that funding for research and technology development has been decreasing for years. Glenn Research Center has needs that should be addressed also and I will work obviously with the Ohio delegation to ensure that those needs are communicated to and understood by your administration.

With regard to the new plan, on the surface it looks as though there will be some large or significant role for NASA Glenn, given Glenn's expertise in aeronautics and space research. However, I am concerned that as the plan changes, and it has since we started talking about it, Glenn and other research centers stand to lose the funding dedicated for technology and development. These concerns are already being validated as you stated in April that the revised plan to develop an ISS emergency return module would change the amounts requested for exploration technology programs. Now, how much do you see that these programs are going to be cut and what will be the impact on NASA Glenn? And further, should we be ex-

pecting more announcements of initiatives that will cut funding for technology development?

Mr. BOLDEN. Congresswoman, as I mentioned before, the amount that I would spend on or that I would dedicated to technology development will probably go down by some amount but I just want to refer people to the latest Aviation Week and Space Technology because I want to make sure that NASA stays in trade magazines like this, and there is quite a bit about NASA's contribution to clean aviation and aeronautic development, and we are going to do more of that and that is why I told the chairman that one of the things that is not eligible to messed with, if I want to use that term, is aeronautics. We have an incredible facility in Plum Brook at Glenn that has the capability of bringing in large spaceflight. Orion, any of the commercial entities can bring them there. Foreign partners can bring large spaceflight there. We have got to get out and do some work, though, to let people know that we have these facilities, that we are credible when we have discussions about aeronautics, and we lost some of our credibility as we stopped spending money in research and development, and I want to restore credibility and respect to NASA and the aeronautics community. So as I have said to you and the Ohio delegation before, that is something that I promise and I am not backing down on that.

Ms. FUDGE. Secondly, what do you see as the role for NASA Glenn and other centers in working with the commercial space transportation industry to accomplish NASA's human spaceflight objectives?

Mr. BOLDEN. Unless we work with the commercial entities and the commercial entities work with us, then everybody's worst fears will be realized. This is a partnership. The tighter we can make the partnership between NASA and the commercial entities, just as we have done on the International Space Station, it is a model for the way that I would love to see our NASA commercial partnership. We depend on each other. We can't survive without each other, and that is the way I want the NASA commercial partnership to be. They need us and we need them. We have facilities that they can use to buy down risk on their vehicles. These are development programs, and they can do it alone, so we are here to help them and we are going to do that, and we are going to put demands on them because there are certain criteria that they are going to have to meet. They are going to have to meet human rating standards. They are going to have to comply with safety standards. And so those things will not change. I am not putting a human being in a commercial spaceflight that does not meet the standards that we would do with a NASA vehicle.

Ms. FUDGE. Thank you, Administrator Bolden. I am warming a bit to the plan but I certainly am going to wait until I see the budget and hopefully answer some of the questions that have been asked today. Again, I thank you for being here.

Mr. Chairman, I yield back.

Mr. BOLDEN. Thank you, ma'am.

Chairman GORDON. Mr. Smith is recognized.

#### MAINTAINING THE INTERNATIONAL SPACE STATION

Mr. SMITH OF TEXAS. Thank you, Mr. Chairman.

Mr. Bolden, the current shuttle manifest was developed at a time where the prior Administration had established 2015 as a termination date for the International Space Station. Given that the Administration has now proposed extending its life through 2020, which I think is a good idea, what additional needs will the ISS have in terms of spare parts, cargo and crew, and how will those needs be met with Russian, European or U.S. commercial vehicles.

Mr. BOLDEN. Sir, the biggest need for International Space Station post this last flight when we put the last big module, the Russian module, is for piece parts, small parts. One of the obligations or one of the requirements of the commercial entities is that they be able to carry 40 metric tons to orbit. We have a capability of delivering 85 percent of the volume—not the volume but the up mass that we had on shuttle with both HGV, the Japanese carrier, and ATV, the European carrier. They were both demonstrated and performed flawlessly in the past year. So, you know, we won't have a shuttle to take huge pieces and parts up but there is no requirement for that. We have sufficiently outfitted the station that we can service it with—

Mr. SMITH OF TEXAS. Let me ask you a related question, and that is, what will the Russian crew services cost and aren't they going to be a lot more expensive now than they were before, and I think that is in part because the Russians will have a captive market if the shuttle is retired as planned.

Mr. BOLDEN. Congressman, we just—

Mr. SMITH OF TEXAS. Aren't they going to corner the market and therefore the cost will be greater?

Mr. BOLDEN. They will not have a corner on the market, and that is what I am trying to ensure for all of us. When we have commercial vehicles available, and I hope to have more than one carrier, contrary to what everybody thinks, if we stuck with the Constellation program, we would be down to one way to get to orbit with the Russians as a backup. When I am successful in facilitating the success of the commercial entities, we hope to have a minimum of two commercial carriers backed up by the Russians so we will have three ways to get people to orbit, which is one more than we would have had with the Constellation program and one more than we have today.

#### THE SEARCH FOR EXTRA-TERRESTRIAL LIFE

Mr. SMITH OF TEXAS. Mr. Bolden, the last question on a very different subject. What efforts is NASA making to detect life, perhaps sentient life, elsewhere in the universe and how important do you think that is?

Mr. BOLDEN. That is critical. I am glad you asked that. NASA has a number of missions that are flying right now that are looking for Earth-like planets around other suns, the millions of suns in the universe as we know it. WISE [Wide-Field Infrared Survey Explorer]—I forget what the acronym stands for—is an infrared imaging satellite that we just put on orbit the end of last year. It is imaging the entire universe as we know it and help us identify things like asteroids, Earth-like planets and the like. So we are making a serious effort to find out if there is other life out there.

Mr. SMITH OF TEXAS. Any new proposed efforts that you are planning to suggest in the next couple of years?

Mr. BOLDEN. Let me get back to you, Congressman Smith. I am certain there are, and my science friends are going to be angry that I can't tell you right away but I know there are.

Mr. SMITH OF TEXAS. And there are some nodding heads behind you saying yes as well, so I will look forward to that.

Mr. BOLDEN. They taught me to say I don't know.

Mr. SMITH OF TEXAS. Thank you.

Mr. BOLDEN. I don't know, but I will—

Mr. SMITH OF TEXAS. I will look forward to hearing back from you in that regard.

Thank you, Mr. Chairman. Yield back.

Chairman GORDON. Thank you, Mr. Smith.

And Mr. Matheson is recognized for five minutes.

#### FIXING CONSTELLATION

Mr. MATHESON. Thank you, Mr. Chairman.

Mr. Bolden, thanks for coming today.

Mr. BOLDEN. Thank you.

Mr. MATHESON. Given the many unanswered questions of the proposed fiscal year 2011 NASA plan, it seems to me that we ought to be careful about writing off all the hard work and investment made in the Constellation program, so what I would like to hear from you is, have you tasked your NASA team to take a close look at the Constellation program to see what changes, what streamlining, what alternative approaches to doing business could be taken to lower the cost and speed the development of the Ares and Orion and get us started on a heavy-lift launch vehicle sooner? Have you had folks tasked to look at that issue?

Mr. BOLDEN. So we have a number of tiger teams that we have discussed in many panels in testimony before that are looking at identifying the nuggets in the Constellation program that we want to keep for programs going ahead. We have a group that is looking at insight and oversight, how do we streamline the amount of oversight that we exercise as we bring the commercial entities on board because they will come. Even with the Constellation program, we will be bringing commercial entities on board. That was started by my predecessor. I didn't—President Obama and I didn't start that. This has been on the books for some time, just not very well funded. So we are looking at ways to decrease the amount that it costs us for oversight without losing emphasis on safety.

Mr. MATHESON. Maybe I will ask the question a different way, though. It sounds like the decision was made not to move ahead with this program, and I am suggesting, have we really looked at if there are ways to continue the program under a more cost-effective manner?

Mr. BOLDEN. Congressman, the decision has not been made not to move ahead with this program. I am prohibited by law from taking that step. The President and I think the proper thing to do, the prudent thing to do is stop work on Constellation in 2011, take the nuggets from it and proceed with a more viable program, but right now we continue to work with all deliberate speed on perfecting

what we have in Constellation. You know, we will do all we can until the end of this fiscal year.

Mr. MATHESON. I just appreciate a concerted effort to make sure we examine all the options before we dismiss something that has had a lot of effort put into it.

Mr. BOLDEN. Congressman, you may remember that two weeks ago we conducted an incredibly successful test that was called PA-1, Pad Abort 1. That was on a launch abort system for Orion in the Constellation program, and I thought, we all thought that was essential to get that test behind us because we think that is going to be valuable no matter what we go with.

#### SOLID ROCKET INDUSTRY AND WORKFORCE

Mr. MATHESON. Let me ask you another question. What do you think is going to happen to the unique workforce that our Nation's defense programs rely upon for the future needs in the solid rocket motor industry if the proposed cancellation of the Ares program is upheld?

Mr. BOLDEN. Congressman, the leadership in the intelligence community, the leadership in the Department of Defense and I are working diligently together now to identify what the Nation's need is in terms of solid propellant. We are unique. NASA is unique in requiring large, segmented, solid rocket motors that right now mostly, I think most of the production is done in a facility called Baucus in Utah. That industry cannot, I think, afford the infrastructure that it currently has and we are working with them to try to entice them to make business decisions that will get that under control because I have not given up, you know, on the need for solid fuel yet. There is an incredible workforce there, an incredibly talented workforce that we cannot afford to lose so the intelligence community, DOD and NASA are working to try to find a way to transition from where we were grossly overcapitalized up until now to a more viable market there.

Mr. MATHESON. Well, I appreciate your acknowledgment of the talented workforce that is there. It is also one that is diminishing as we speak in terms of layoffs, and I would just ask that as all these items are put on the table, we should recognize that this workforce capability is not something that once it goes away you can just recreate instantaneously. Once it goes away, it will take years to put that back together again, and I think that that is an important criterion that ought to be front and center as you look at these decisions. I appreciate you coming today. Thank you so much.

Chairman GORDON. Thank you, Mr. Matheson. And whatever the final decisions are, we need certainty so that that workforce will know what they are going to be doing or not doing.

Mr. Rohrabacher is recognized for five minutes.

#### SAVINGS FROM ARES CANCELLATION

Mr. ROHRABACHER. General, could you tell us how much money was saved that would have been expended for the Constellation Ares project had it not been canceled over a number of years?

Mr. BOLDEN. Congressman, we have not saved any money because we continue to spend on the fiscal 2010 budget profile so the savings will come in fiscal 2011 and beyond if we are able to craft a budget that is agreeable to this Congress and the President. So we are still on the same funding profile with the Constellation program as we always have been.

Mr. ROHRABACHER. So the cancellation of the Ares rocket was not—I mean, I understand we spent almost \$10 billion there.

Mr. BOLDEN. Congressman, I have not canceled it. We have come to the point that we are still planning and looking at future tests for an Ares I rocket. I can't stop that. We did Ares I-X as a demonstration as we had promised, we would do it again. It was incredibly successful. My dilemma, to be quite honest, is, I am obligated to proceed with a program that I really think we need to stop in order to be able to fund the types of programs that are needed to take us into the 21st century and continue our leadership.

Mr. ROHRABACHER. Then let us approach this question in a different way then. If you were able to stop that program, which I was under the impression you were in the process of doing—

Mr. BOLDEN. I can't do that.

Mr. ROHRABACHER. All right. Thank you for clarifying that for me. How much money are we talking about saving? And when we say saving, I am not talking about—we are talking about money that will be spent in other aerospace endeavors, not things that will take away from these jobs and America's capability but will add to it in a different place. How much money are we talking?

Mr. BOLDEN. Congressman, let me get back to you because that is a much more complicated question than I am prepared to answer, and it is not simplistic. You know, when I talk about composite tanks and different propulsion systems, I think they represent a cost savings between what we now have with Constellation and what we would have with a new program with a different heavy-lift launch vehicle, a modified Orion. So I will get back to you.

Mr. ROHRABACHER. We are talking about considerable amounts of money. We are talking about—

Mr. BOLDEN. Congressman, I don't like to use superlatives. I know there is a cost savings but let me get back to you.

Mr. ROHRABACHER. All right. I am looking forward to that.

Mr. Chairman, when people are trying to spend money to do everything, they end up not being able to get anything done, and one thing I have noticed since I have been in Congress is this inability of Congress to prioritize, just total inability to prioritize, and when someone does, at that point they are always focused on saying well, we are eliminating something rather than realizing that the funds for that are now being used in other endeavors that could be very justifiable.

#### COST OF A CREW RESCUE VEHICLE

Let me ask you in detail while I have the time here. The crew return vehicle, what is going to be the total cost for that?

Mr. BOLDEN. Congressman—

Mr. ROHRABACHER. The crew rescue vehicle.

Mr. BOLDEN. I will get you the entire numbers. The cost up front we estimate is \$4.5 billion over five years, but let me get you—

Mr. ROHRABACHER. So almost \$5 billion over five years, and then on top of that operational costs, and that will permit us to have a rescue system, a lifeboat at the station for how many years?

Mr. BOLDEN. I have to get back to you on that also. That is an operational—that is an issue of operational concept. I would like to get out of that business as quick as possible and get the commercial entities to assume that responsibility.

Mr. ROHRABACHER. Let me get to the point because I only have a few seconds left. The money that would be spent for us developing that is \$5 billion minimum, it looks like, how much would it cost us to rent that capability or to hire that capability from the Russians and thus freeing that money for us to use in other aerospace endeavors?

Mr. BOLDEN. Congressman, that is one thing I can give you per seat, and it is cheaper. Right now, approximately, and this is a rough approximation, \$50 million to \$57 million per seat with the Russians. That includes training, transportation, everything. So we all need to understand that cheap is not what we are looking for. We are looking for domestic capability, and—

Mr. ROHRABACHER. Well, it seems to me that if we are developing a domestic capability at the cost of \$5 billion that we could actually be doing for considerably cheaper. That means we are denying other aerospace projects that amount of money in order to have a crew rescue vehicle on the space station, which we know in a few years is going to be obsolete and we are going to fly away from that and it will be part of history. Maybe we should be, instead of investing those billions of dollars in something that will be history within a short time, maybe we should be investing in future-oriented technology that will make us competitive with the Russians in the future, in fact, more competitive than anybody else, rather than depending on the Russians in the future as well because we have managed to spend all of our money in the past.

Chairman GORDON. Thank you, Mr. Rohrabacher. I don't mean to cut you off but we have a lot of witnesses and we are going to try to stick with our five minutes or, you know, shortly thereafter.

Ms. Giffords, the chair of our Space and Aeronautics Subcommittee, is recognized for five minutes.

#### CONTINUING WORK ON CONSTELLATION

Ms. GIFFORDS. Thank you, Mr. Chairman, and Ranking Member Hall. Welcome back to our Committee, General Bolden.

You earlier referenced the successful launch of that abort system test flight, and this was truly a significant milestone for the Constellation program to develop the systems that are going to take us back safely to the International Space System and beyond low-Earth orbit. It is a real testimonial to the success of NASA and our contractor team, who made it an incredible success. This was a three-year development. It cost approximately \$220 million, again, a credible first step in ensuring the safety of future spacecraft crews, and it was really clear after the *Challenger* accident that in order to safely carry the crew, we had to be able to present an escape system that would not harm them during ascent, and again,

this was an important requirement that was a critical part of the design for Orion and for Ares I and the inclusion of the launch abort system is projected to really make this the safest combination to get back to the ISS and beyond.

I would like to actually show a short video clip if that, if we could cue that up, because about 3 weeks ago, and I am not sure all the members actually saw this, but NASA and its team of contractors showed us how it is done. So let us take a look here.

[Video playback.]

The Pad Abort-1, as NASA called it, was the first successful U.S.-designed abort system since Apollo, incredible feat, and congratulations to you and your team. But even before the test, Popular Science magazine honored the launch abort system with a Best of What Is New Award for 2009 in the aviation and space category, and as you just said, General Bolden, you said this was an incredibly successful program and you thought it was essential, a valuable tool to wherever we go. Sadly, that hard work and that dedication have not been rewarded. Space News reported on the eve of the test that one of the contractors warned its subcontractors supporting development of this that funding for the effort would cease as of April 30th.

Administrator, Bolden, you and I both know that actions are being taken to make it hard for the team to accomplish their work during the remainder of this year. It is not a mystery to this Committee and to all of the industry folks out there. All of this is happening despite the efforts of Congress and us saying that work on Constellation needs to continue, and based on the lack of Congressional support for the President's proposed plan, I think it is clear that we are going to need the capabilities that we are developing under the Constellation program like this Pad Abort system in the future. I don't have a lot of time to spend talking about legal interpretations of termination liabilities and other issues. However, it is very clear that there is a lot of uncertainty within your agency and in the contractor community about what is going to be done to Constellation this year. There are a lot of rumors floating around about termination of high-ranking members of your administration that are working to really execute the will of the Congress. So I would like to—and I only have a minute left—but just a couple of yes-no answers to some simple, direct questions.

Administrator Bolden, will you give this Committee your assurance that you will take all feasible measures to ensure that NASA makes as much progress as possible on Constellation in the remainder of the fiscal year 2010 and will you direct your workforce to do the same?

Mr. BOLDEN. Yes, ma'am.

Ms. GIFFORDS. Will you direct your Constellation Orion workforce to give highest priority to carrying out activities that maximize progress on the Orion crew exploration vehicle program and not divert efforts in the fiscal year 2010 to the yet-approved crew rescue vehicle program?

Mr. BOLDEN. Yes, ma'am.

Ms. GIFFORDS. And finally, will you ensure that your workforce complies with the intent of Congress that work continues on Constellation until such time as the Congress decides otherwise and

that work on all aspects of the Constellation program over the past five years shall take precedence over the activities and the programs proposed by the President in his fiscal year 2011 request that may wind up never been approved by the United States Congress?

Mr. BOLDEN. Yes, ma'am, and that is the direction I have given as late as last week. That was essential the guidance I provided to the Constellation program was to do those things that you just mentioned.

Ms. GIFFORDS. Thank you, Mr. Administrator, and thank you, Mr. Chair.

Chairman GORDON. Mr. Olson, the ranking member of the Space and Aeronautics Subcommittee, is recognized for five minutes.

Mr. OLSON. Thank you, Mr. Chairman, and thank you, Mr. Administrator, for coming to testify today and thank you for your service to our Nation. Thanks again for your phone call yesterday. I greatly appreciate that. Please keep that up, because that is one of the things I think was lacking when this budget was rolled out, and I would like to sort of follow up on my chairwoman, some of her comments.

In your opening statement, you referenced this week's GAO report on the use of study teams to develop plans for the President's fiscal year 2011 budget, and GAO documented thousands of hours devoted by NASA employees planning to implement the President's budget. I would like to caution you that this report was just the first response in ongoing GAO investigation. A full report is slated to be delivered this summer and will focus more on the more important question of NASA's compliance with budget impoundment laws. The report from this week clearly states that the agency, and I quote, "must be mindful of the appropriations provision on canceling or altering contracts in the current program." I would like to reiterate that with you as well.

And following up on my chairwoman's comments, I mean the Pad Abort was an incredibly successful launching test but there were rumors, if you recall, back in January and February that NASA was looking to cancel that. Again, NASA does not have that authority with the appropriations language. The President and the Administration have a voice in this process but they don't have the ultimate say. We, the United States Congress, has that, and I just again caution you not to read too much into that GAO report. We will get more details later on.

#### PRESIDENTIAL VISIT TO THE JOHNSON SPACE CENTER

One question for you, and you live back in the District as well, and one question—

Mr. BOLDEN. Not very much.

Mr. OLSON. I am similar to you. I am here today and I would much rather be back home with my family, but what we are doing here is important. But one question I get asked a lot, and I would like you to help me answer it, is when is the President going to come to the Johnson Space Center and see the home of human spaceflight? When is he going to give us some time? I mean, I know he went down to Florida and made the speech there and he took a tour of one of the commercial operators and gave them a half an

hour. When is he going to come down and give us a couple of hours just to see what incredible things are being done there at Houston and what is at stake with some of the implications of the budget he has proposed?

Mr. BOLDEN. Congressman, I am working on that, and unfortunately, I can't give you a date certain but I am hoping he will let my granddaughters come and meet him before he goes to the Johnson Space Center since they are going to be here in about a month.

Mr. OLSON. Anything you can do to get him down there, because again, I get asked that all the time. People don't understand why he won't come down and see us in Texas or the home of human spaceflight. I mean, we had a great mission, as you know, with *Atlantis* today. I was a little sad seeing her land, knowing that that is probably the last time that she is going to roll out and is going to become a museum piece.

#### NASA'S PRIMARY MISSION

One other question just sort of philosophical for you that is kind of on my mind. You know, NASA does many, many things, human exploration, robotic exploration, research development, technology development, climate monitoring, you know, aerospace, aeronautics, but we have a limited budget and we struggle, and that is the struggle we are facing today with what has happened here with the Constellation program. We haven't given you the resources you need to do what we have asked you to do as a Nation. But as the administrator, if you could pick one thing, one thing for NASA, what do you think their primary mission focus should be? Should it be human spaceflight exploration, robotic exploration, research and development? I know it is a tough question but I just kind of want to see what your thoughts are on that.

Mr. BOLDEN. It is a pretty easy question for me because they are all intertwined. You can't—human exploration without research and development is unexecutable. Research and development without a human exploration program trying to pull that technology is useless, and that is really the—the debate we are having and the difficulty in my bringing you what I need to bring you is, it is really complex trying to determine—you know, human spaceflight is critical. We cannot do it without research and development and development of new technologies as Congressman Rohrabacher said. We tried that and it doesn't work. I don't have anything in NASA—we do STEM. We do science, technology, engineering and math whether people like it or not, and I know that is an educational term but education is also critical in what we do because if I am not allowed to do education and expend money and resources, people on that, I am going to have nobody that I can take from a college campus who is an engineer, so I would love to be able to tell you all that it is very simplistic. What I love about my job is, it is very complex, complicated and nuanced, and that represents an incredible challenge. The President is a person who does nuance, and I haven't seen one like that in a while and it is fun to sit and talk to somebody who understands that the world is nuanced, it is not black and white.

Mr. OLSON. Thank you, General, for that answer. I am running out of time here. I would just like to sum up that I think if you

ask the American public what does NASA do, they would see those astronauts in those blue flight suits down the hall earlier today and they do human spaceflight, and that should be our priority.

Mr. BOLDEN. Mr. Schweickart.

Mr. OLSON. Rusty Schweickart. We have got Neil Armstrong, Gene Cernan. I mean, that is what the American public thinks about when you say NASA.

Mr. BOLDEN. I agree.

Chairman GORDON. Thank you, Mr. Olson.

And Mr. Miller, the chairman of the I&O Committee is recognized.

#### SPACE COMMUNICATIONS NETWORKS SERVICE CONTRACT

Mr. MILLER. Thank you, Mr. Chairman, and my first question has to do with the work of the I&O Committee. We understand that NASA is on the verge of awarding the acquisitions contract for the space communications networking, SCNS, contract. It will be the third effort. The first two, there were complaints to GAO and the GAO found that there were organizational conflicts of interest that infected the award process and set the awards aside. We understand that in the early summer, and Monday is Memorial Day, NASA will try for a third time. Our subcommittee has been looking at the award of the contract, the contract acquisition process. They have interviewed 30 people. They have reviewed 20 boxes of documents. They will shortly issue a staff report that I understand will be very critical of NASA's failure to understand the importance of dealing with conflicts of interest rather than just something to kind of get through a process and make sure it doesn't get set aside, that there is actually a purpose behind the organizational conflict of interest. Since you are apparently on the verge, NASA is apparently on the verge of awarding the contract for the third time, we are apparently on the verge of issuing a staff report examining the contract, will you hold off on awarding the contract until you see the result of our staff committee report?

Mr. BOLDEN. Congressman, as much as it pains me to say, I will have to get back to you on that because I am familiar with about what you speak but not familiar enough to give you an intelligent answer, so I will get back to you.

Mr. MILLER. If you could do it quickly because—

Mr. BOLDEN. I will do it quickly, sir. I can get back to you this afternoon. I just don't—I don't have the information before me. Somebody just slipped me a note, but I always get in trouble when I read notes and I don't know what—

Mr. MILLER. I will look forward to your call.

#### SPACE TOURISM

Second, some part of the justification for commercial crews is that NASA would not be the only customer. It would make possible spaceflight for others, and I have got to say, the idea of taking a vacation of going to space does sound massively cool. But it also strikes me as probably pretty pricey, and Chairman Gordon asked back in February if you had done any kind of market survey to determine just exactly what the market was for space tourism, and

your answer was that NASA had not but that there had been private industry surveys, and we found one. Futron Corporation estimated back in 2002–2003 that the cost would be \$20 billion to go. They seem to assume that—

Mr. BOLDEN. Million.

Mr. MILLER. Million to go.

Mr. BOLDEN. Yes, sir.

Mr. MILLER. And they estimated then that there might be 23 people who would go on Soyuz flights at that price. They now estimate that the price might come down. If it did come down to \$5 million per ticket, that might make it possible for people with net worth as low as \$50 million to go by 2021. There is other information that \$5 million per ticket is wildly optimistic, that it is probably going to say in the—probably an absolute or more likely price tag or ticket price would be \$50 million. What part of the justification for commercial crews is space tourism? How much of the \$6 billion, \$7 billion a year we are spending for five years is directed at what is going to strike a lot of Americans as something that is beyond, probably will always be beyond their reach?

Mr. BOLDEN. Congressman, none of our effort is directed at space tourism. Our effort is directed at a commercially available option to get to low-Earth orbit. What is important to me is to be able to get scientists and investigators from Earth to the International Space System. You know, that is—I know that we need to be able to get people there. If there is a commercial availability to get them there, then we can increase the numbers of people who can do research on the International Space System as an example. There are other examples that people can cite of hopes for other facilities in low-Earth orbit, you know, where a commercial entity to get them there would be very good.

Mr. MILLER. I am sorry. Say that again.

Mr. BOLDEN. There are other examples that people can cite for you if you talk to a company like Bigelow, for example, who have inflatable structures. They have a couple that have been on orbit for some time now surviving with nobody in them but still surviving as a demonstration. There are entities out there who have a need for a way to get to space, and that is the commercial entity that I want to facilitate the success for.

Mr. MILLER. Not space tourism?

Mr. BOLDEN. Space tourism is fine, but that is someone else's business model. That is not a NASA—that is not something that is in my purview. I think that is great.

Mr. MILLER. My time is expired.

Chairman GORDON. Thank you, Mr. Miller.

And Mr. Sensenbrenner is recognized for five minutes.

#### MODIFYING CONSTELLATION

Mr. SENSENBRENNER. Thank you very much.

General Bolden, welcome. Let me say I am a little disturbed at the President's budget submission, and 49 years ago when I was still a high school student, I remember seeing President Kennedy on TV giving an inspirational speech which united Americans and talked about putting a man on the moon. And the President's speech at the Kennedy Space Center I think is a U-turn from what

President Kennedy had to say to us, and certainly has deflated the hopes of a lot of people in terms of America keeping its edge in space technology.

Now, so far we have spent \$10.3 billion on the Constellation program, and I guess if it is terminated that is \$10.3 billion wasted or spent on something that was a dead end. Has NASA or the Administration given any consideration to modifying the program if they determine it to be too expensive rather than stopping it altogether?

Mr. BOLDEN. You are referring to the Constellation program?

Mr. SENSENBRENNER. Yes, sir.

Mr. BOLDEN. Sir, we are not looking at a way to modify the Constellation program because we feel that the amount of money that would be required to bring that program up to a point where it is viable is more than the Nation can afford.

#### TERMINATION LIABILITY

Mr. SENSENBRENNER. Okay. What termination liability does the Federal Government have if the Congress approves the President's recommendation? How much money?

Mr. BOLDEN. The termination liability is a requirement on the part—that is a requirement that is laid on the contractor as a part of the contract, and we recently went through a lot of deliberation on that back and forth with attorneys, but the termination liability is something that is a responsibility of the individual contract.

Mr. SENSENBRENNER. Now, how is that? If the determination to terminate the program is made by the Federal Government, that seems to be a pretty bad contract.

Mr. BOLDEN. Congressman, I am not an attorney and I do not know why we introduced that type of clause into contracts but it is in most of our NASA contracts—

Mr. SENSENBRENNER. Well, I am an attorney, with all due respect, and if all of a sudden if the Administration and the Congress agree to terminate the Constellation program and the contractors end up holding the bag, how do you ever expect them to sign another contract with NASA?

Mr. BOLDEN. Congressman, what most businesses do from my very limited experience on the outside serving on corporate boards is that the board with the management structure of the company makes a risk decision that okay, we are going to go into this business because we are not sure that our client, our customer is reliable, we are going to hold back some money just in case he finks on us, and people who work with the U.S. government unfortunately are very accustomed to that.

Mr. SENSENBRENNER. Does NASA want to get a reputation of finking on contractors and big programs?

Mr. BOLDEN. Mr. Chairman, we do not want to get that reputation but I would be lying to you if I didn't say we haven't. Everyone sitting in this room can line up, you know, we can line that wall up with NASA programs that have been canceled and it comes with changes of Administration, it comes with changes of mind. One of the problems that we have philosophically as a people is we can't see beyond a four-year horizon, and all of you sitting in this room are having a very difficult time seeing beyond a two-year horizon,

which comes down to a one-year horizon when you have to run, and I don't—

#### ABDICATING LEADERSHIP IN SPACE

Mr. SENSENBRENNER. Sir, with all due respect, this Committee on a bipartisan basis has written and passed into law multiyear NASA authorization bills, which are much beyond a two-year horizon minus whatever part of our two-year terms has already elapsed. Now, I will be very honest with you, sir, this is a U-turn and I think that there are a lot of people who still have the vision of President Kennedy who think that the United States is abdicating its leadership in manned spaceflight as a result of the U-turn and they are really puzzled when they see the Administration asking for \$23 billion to keep laid-off teachers on the payroll but they don't have enough money to follow the \$10.3 billion that we have already spent in building the Constellation program. If you want to look at the future, I would suggest that if it is too expensive, let us modify it, because I have a real bad time justifying to my constituents that well, we spent over \$10 billion of your money and we decided we can't get anything out of it. And I am not going to do that, and I think that if the President and his NASA administrator want to do that, you are going to have a tough time convincing the American people you are right.

My time is up. Thank you.

Chairman GORDON. Do you want to give a quick reply?

Mr. BOLDEN. A quick reply would be to say, I don't consider it a U-turn, I consider it, there are many ways to get where we all want to go. We all want to get to Mars. Constellation would not have gotten us there. The President's new program will get us there. It will take us—we will go in incremental steps where we were trying to go in one big chunk before and we just—we are not going to get there.

Chairman GORDON. And Ms. Woolsey is recognized for five minutes.

#### SAFETY REGULATIONS FOR COMMERCIAL SPACEFLIGHT

Ms. WOOLSEY. Thank you, Mr. Chairman.

Administrator Bolden, hello. Thank you for being here.

Mr. BOLDEN. Thank you.

Ms. WOOLSEY. You said a couple of things that made me stop and sit up more than once today. One is, you have said in response to questions on different issues they won't be perfect. And then we talked about commercial crews and commercial vehicles. So boom, I started thinking, well, the safety of the crews, the safety of the workers, the safety of human flight being commercial and not under NASA as we know it, and as the chairwoman of the Workforce Protection Subcommittee in Labor, I really want to know how we are going to make sure that we have safety regulations for these commercial flights. We just keep experiencing private industry taking risks, cutting corners, having shortcuts, cost savings, timing and then what we have got? With this, we are particularly vulnerable, we get people up there in space. So what are you thinking in that regard for NASA?

Mr. BOLDEN. Congresswoman, we are modifying, we are looking at the way that we exercise our oversight over the work that is done by the contractors. I think I spend too much time and effort and money on that oversight today, and that is a contributor to the increased cost of programs. I don't need to have 20 NASA people overseeing 20 contractors to ensure safety. I can do that in a much more streamlined manner. I would—going back to the video that Congresswoman Giffords showed, I am glad she showed it because I would remind those—I would remind some and I would inform others that the integration contractor for everything you saw was Orbital, a company out of Dulles, Virginia, and it happens to be the same Orbital that is one of the top producers. They are a reputable aerospace company that has produced very successful products in the past, and as I have said to other people, I refuse to accept the contention that an American company cannot do what the Russians do through Energia. I refuse to accept the fact or the belief that we can't help our American manufacturers produce an incredibly safe vehicle to get humans from Earth to low-Earth orbit and then beyond. Boeing is going to be working on—they worked on the International Space Station. They will be working on the low-Earth orbit vehicle, but Boeing is also probably going to be involved in the NASA production of a beyond-LEO vehicle. It is the same company, the same people, and I just cannot accept the fact that they will be less capable because they are making money running a commercial entity than they are going to be working for me taking people beyond low-Earth orbit.

Ms. WOOLSEY. But working for you, NASA, is responsible for the oversight.

Mr. BOLDEN. I am responsible no matter whether I procure their services by buying the vehicle or by leasing the vehicle. The only difference is the acquisition strategy. I am not relinquishing my responsibility for guaranteeing safety of crew and cargo just because I lease the vehicle. When I lease the vehicle, it belongs to me. You know, is it like going to a little airport on the way to Annapolis, and I don't own the airplane—I don't fly—but my friends don't own the airplane. They lease it and they go fly, but they are responsible for that airplane while they are flying it. That is the way I am going to be when I fly astronauts and cargo on a commercial entity. I lease it; I own it for the time being. The difference is, I don't have to pay the overhead, I don't have to pay the infrastructure, so there is—going back Congressman Rohrabacher's point, I reduce the amount of money that the taxpayer has to pay because the taxpayer is not strapped with infrastructure and operational costs when I am not flying that vehicle. It is \$2 billion a year if I don't even launch the space shuttle. We can't afford that.

Ms. WOOLSEY. So you will have the same safety procedures and processes—

Mr. BOLDEN. Yes, ma'am. I will have the same effect when it comes to safety and oversight. What will be different, I can promise you, I will not have the same number of people, for example. I will not have the same number of boards at the Johnson Space Center that has to meet before we give a go to fly a vehicle. When I was in the space program, we had a program requirements control board and a CCB—I forget what they stand for. When I go to the

Johnson Space Center today, they have grown to 10, 12, I don't know how many boards, and I have still got to get to the top for the decision to launch. I don't need all that.

Ms. WOOLSEY. Thank you, Mr. Chairman.

Chairman GORDON. Dr. Bartlett is recognized for five minutes.

#### PROMOTING STEM FIELDS THROUGH NASA

Mr. BARTLETT. Thank you.

I want to ask you about your commitment to what I think is the most important contribution that NASA can make, and I need to put this in context. As the school physiologist at the school of aviation medicine in Pensacola, Florida, in the late 1950s, I was involved in the first suborbital primate flight, monkey Baker and monkey Able. Monkey Able was killed by the Army when they gave a general anesthetic to take the electrodes out. We didn't do that to our monkey Baker in Pensacola, so she was kind of a star for a long time. There were seven astronauts at that time, the first seven, and NASA had no facilities. So they were using military facilities. They came to Pensacola to use the human centrifuge and the slow rotation room and they came to the naval yard in Philadelphia where I had temporary additional duty to use the altitude chamber. Dino Mensanelli, obviously of Italian descent, was the director of that and they were testing one day, and I have heard Dino tell this story a number of times. He thought it was very funny. They were testing a pressure suit and it was making a noise. The air part was making a noise. And he asked the astronaut, I forget which one it was, what it sounded like, and he said well, if you will excuse me, it sounds like waff, waff, waff. And I heard Dino tell that story many times. What happened then, I was much older than Sensenbrenner and I was already working as a scientist in a career when he was in high school, but I remember that speech of the President, and I remember the enormous contribution that that made to our country in terms of capturing the imagination of our people and inspiring our young people to go into careers in science, math and engineering.

Today we are the world's premier military power, and I think that is largely due to what NASA did during that slightly less than a decade that we spent putting a man on the moon because it really did capture the imagination of our people and inspired our young people to go into these careers, because I remember a cartoon, a bucktoothed, freckled-face kid and he said, you know, six months ago I couldn't even engineer and now I am one. Everybody wanted to go into science, math and engineering, and I think that our pre-eminence today in defense is largely due to that.

Today we face a huge challenge, as you know, sir. This year the Chinese will graduate seven times as many engineers as we graduate. India will graduate three times as many engineers as we graduate. The best and brightest of the kids in our country are going into what I tell them are potentially destructive pursuits, if you will excuse me, that are wanting more and more to become lawyers and political scientists. Don't you think we have enough of both of those? We desperately need, sir, something that captures the imagination of our people and inspires our young people to go into science, math and engineering or we will not retain our pre-

mier position as the best, most powerful military force in the world, and to say nothing of technology and leading in that area. What is NASA going to do that is going to capture the imagination of our people and inspire our young people to go into these technical careers? Because, sir, I think that is the most important contribution that NASA can make. What are you going to do that is really sexy and catches on?

Mr. BOLDEN. We are going to continue to do some of the work that we have been doing and expand it even more through some of the—again, I will have to go back to my educational initiatives. This summer, through a program called the Summer of Innovation, for example, we are going to allow—working with the Massachusetts Space Grant Consortium, we are going to allow middle-school kids to write programs that will allow three spheres on the International Space System to maneuver around inside the station, do intricate maneuvers that we need to be able to do if we are going to be able to rendezvous with a refueling base in space or something. That work is being done right now by doctoral students and post-docs at MIT. But this is something that they decided they wanted to take all the way down to the middle-school level. There is a program that is not a NASA program called First Robotics but NASA supports that with 312 teams that we provide mentors for. The Nation doesn't pay a dime for that. That is time that our engineers and scientists dedicate because they think it is important. And First Robotics, if you have not seen it, it is absolutely incredible, and that inspires the imagination of kids.

There are kids—there are more stories from First Robotics about former gang leaders who had their lives turned around because they got involved in First Robotics, so I am not going to tell those stories because the chairman would shoot me for taking all that time, but I would recommend that we all take a look at some of the things that have been done through NASA, through the National Science Foundation, through other organizations that do inspire kids. You know, they don't need to see somebody go to the moon, it is helpful, but they all realize they can't go to the moon.

Chairman GORDON. Thank you, Mr. Administrator.

I just want to suggest that Mr. Armstrong, Mr. Cernan and Mr. Young are waiting on our second panel. Everyone certainly has the right for their full time, and we are going to continue to go forward, but if you don't feel like you need your full five minutes, don't feel like you have to take it, and Mr. Bolden, you can also, if you have got your message across, you can go to the next one also.

So now, Mrs. Dahlkemper, I don't mean to put you under the spotlight here but you are our next speaker and I recognize you for five minutes.

#### ASTEROID MISSION

Mrs. DAHLKEMPER. Thank you, Mr. Chairman, and I will try to be very quick.

Thank you, General Bolden, for being with us, and I have been to some of those First Robotics competitions and they are exciting and really do inspire me as well as certainly the students.

I just have a quick question. As the President announced a plan for a manned flight to an asteroid, that captures my imagination

actually, and so I just would like you to maybe tell me what we have available to us right now to attain that goal. Are we starting from scratch on that? Just give me a little bit of background on this.

Mr. BOLDEN. I can give you a quick example. The jet propulsion lab and the Johnson Space Center, the Glenn Space Research Center and Marshall, those centers are presently talking about an early visit to an asteroid using a lot of off-the-shelf technology, electric engines that we call Hall Thrusters that will enable us to rendezvous with an asteroid perhaps as quickly as 2016 just as a demonstrator. It is a robotic precursor, not a human mission, but it gives us an opportunity to demonstrate that we do in fact know how to rendezvous with this thing that is orbiting the Sun. That is what makes asteroids so challenging. They are not—you know, we have ephemeral data on other stuff but we don't on asteroids.

Mrs. DAHLKEMPER. So this is unmanned?

Mr. BOLDEN. This is unmanned.

Mrs. DAHLKEMPER. And when would you expect that we would be able to get manned?

Mr. BOLDEN. I promised the President that if I get my act together, we will do it in 2025, and I think we can do that.

Mrs. DAHLKEMPER. And that is pretty exciting. I am anxious to see that move forward. So I will end there and yield back.

Mr. BOLDEN. When a kid sees—

Chairman GORDON. Thank you, Mrs. Dahlkemper.

Mr. BOLDEN. —a rendezvous with an asteroid in 2016, let me tell you, they are going to be excited.

Chairman GORDON. And Mr. Smith is recognized for five minutes.

#### TIMELINE FOR HUMAN RATED COMMERCIAL LAUNCH VEHICLES

Mr. SMITH OF NEBRASKA. Thank you, Mr. Chairman and Administrator. If you would lay out NASA's schedule for developing and finalizing a set of human rating requirements for commercial crew companies, and once requirements are established, how long do you anticipate it would take a company to design, develop and flight-test and certify a capsule and launch system?

Mr. BOLDEN. Let me get back to you, because we have laid that schedule out and I will get back to you with what it is because we have a request for information on the street, and I talked about it in my opening remarks and we released it sometime this month, asking for commercial entities to look at our draft human rating requirements. Most of the commercial entities have told us that if you put an RFP on the street and we win, we think we can have a vehicle that is human rated in a three-year period of time from the time that the award is made. That is what they say. I am one who takes one at their word until they demonstrate otherwise.

Mr. SMITH OF NEBRASKA. Can you give me a rough time on that?

Mr. BOLDEN. Twenty fifteen, 2016 time frame is what we are looking at right now on our schedule.

Mr. SMITH OF NEBRASKA. Thank you.

Thank you, Mr. Chair.

Chairman GORDON. Thank you, Mr. Smith.

And Lt. Governor Garamendi is recognized for five minutes.

#### CONSTELLATION VARIATIONS

Mr. GARAMENDI. Thank you very much, Mr. Chairman.

By now you have probably figured out this Committee is not with you.

Mr. BOLDEN. Yes, sir, I understand.

Mr. GARAMENDI. And I am curious about several things that you have said. I am going to do this quickly. You said that you are not looking at Constellation Lite, that is, a revamping of the Constellation program. Is that correct?

Mr. BOLDEN. That is correct, sir.

Mr. GARAMENDI. Do you have any authorization to look at any other program besides Constellation?

Mr. BOLDEN. In the 2010 budget, I don't have any authorization to look at anything, and that is why I am not looking at any modification or termination or anything on Constellation. We are working the existing program of record, Constellation—

Mr. GARAMENDI. But yet your testimony here indicated substantial looking at other options.

Mr. BOLDEN. I am doing planning for the President's 2011 budget proposal which I feel is prudent to do.

Mr. GARAMENDI. I will leave it to our lawyers to parse that out.

Mr. BOLDEN. Yes, sir. They are doing that.

#### POTENTIAL COMMERCIAL CREW PROVIDERS

Mr. GARAMENDI. I am sure they are, and they should. You mentioned earlier on the commercialization several companies. Could you explicitly tell us what companies you are looking at to do the commercial operations that are you are planning for next budget?

Mr. BOLDEN. Sir, I don't have any companies that I can say I am looking at. I can tell you companies that I know are thinking about entering the—

Mr. GARAMENDI. Who are they?

Mr. BOLDEN. Boeing, Lockheed Martin, perhaps ATK Orbital, SpaceX, Bigelow.

Mr. GARAMENDI. You mentioned a couple of Japanese and European companies that might be interested in this.

Mr. BOLDEN. We are not—they are not eligible to compete as a prime contractor. They can be involved as a sub to an American firm under our present laws.

#### INFRASTRUCTURE COSTS

Mr. GARAMENDI. Thank you. You also indicated that the private companies would not be burdened with overhead, operational costs, continuing operations and the like.

Mr. BOLDEN. Sir, I did not. That is exactly opposite from what I said. I said I will no longer be burdened with the infrastructure costs, the overhead and everything else. Private companies will incur whatever overhead they normally incur for doing business.

Mr. GARAMENDI. And you don't think you will have to pay for that?

Mr. BOLDEN. We will pay something, as anybody does when they buy a service. There is always—the airlines charge me extra because they are inefficient.

Mr. GARAMENDI. They are private, aren't they?

Mr. BOLDEN. And that is what we are talking about. I am talking about purchasing a service from a public or private company that wants to compete to provide that service in terms of cargo to orbit and humans to low-Earth orbit.

Mr. GARAMENDI. And if you think you are not going to pay for their inefficiencies, you are mistaken.

Mr. BOLDEN. Congressman, I did not say I would not do that. That will be figured in—I am certain they will figure it in to their price.

Mr. GARAMENDI. I am sorry. I don't want to be too argumentative here but it seems to me—

Mr. BOLDEN. I am not arguing. I agree with you.

Mr. GARAMENDI. I am, and I don't want to do that. Just finally, I think you are making a serious error in not looking at Constellation Lite. I think you are obligated to do so. I think you are making a big mistake in not looking at how that might be modified to achieve the goals that you and the President are stating, and to simply push it aside and not move forward with a significant modification or useful modification to meet the requirements of manned spaceflight, whether done by contractors or leasing the equipment. So I will let it go at that. Thank you very much.

Mr. BOLDEN. Congressman, if you could get a relief from the 2010 Joint Appropriations Act that would allow me to—

Chairman GORDON. Thank you, Mr. Bolden. We have covered that topic a few times.

Dr. Ehlert is recognized.

Mr. EHLERS. Thank you, Mr. Chairman. It is my judgment that all the older and wiser people on this panel have already spoken and said everything I would say, so if you don't object, I will reserve my spot for the next panel.

Chairman GORDON. You demonstrate your wisdom right there.

Ms. Kosmas is recognized for five minutes.

#### EXTENDING THE SHUTTLE PROGRAM

Ms. KOSMAS. Thank you, Mr. Chairman.

Thank you, Administrator Bolden, for being here. I do think it is appropriate to mention that we actually had a successful and flawless return of *Atlantis* this morning at 8:48 a.m. and I think it is a great opportunity for us to congratulate both the crew and the workforce once again for the great work done by those folks.

I have a number of different questions. I am going to try to be as brief as I can. I want to talk to you a little bit about a comment that you made that said it is important for us to get scientists to the International Space Station. You also talked about spares and payloads. I want to make a comment. It is my understanding that NASA has completed all the requirements suggested by the Columbia Accident Investigation Board and then some, and that recertification of the orbiters for flights beyond 2010 is essential done. I believe that you would agree that NASA's implementation of the Columbia Accident Investigation Board recommendations on shuttle

and human spaceflight has been successful and that the shuttle's current safety record and the efforts by the shuttle team ensure that all safety risks are addressed for each flight.

Mr. BOLDEN. Yes, ma'am.

Ms. KOSMAS. So would you then agree that flying beyond 2010 into 2011 and perhaps into 2012 is not a safety issue but rather a cost issue?

Mr. BOLDEN. Congresswoman, it is not a safety issue. There are still safety considerations but it is not a safety concern.

Ms. KOSMAS. There would be safety issues with any—

Mr. BOLDEN. There are safety issues with—any time I put a human in a vehicle—

Ms. KOSMAS. So if it is not a—I am sorry to interrupt you. If it is not a safety issue but a cost issue, and the reason I bring it up is, I believe that manifesting the Launch on Need mission, the STS-135, would provide a more manageable draw-down and may help to retain the skills that we need for a future program and it would also be extremely useful in our ability to deliver spares to the space station and to bring down parts that we could conduct engineering analyses on, and I am asking whether you would agree that this would be helpful to us since we have no other American vehicle—

Mr. BOLDEN. I agree that that may be helpful.

Ms. KOSMAS. —to get there. And for the record, do you see any technical or logistical roadblocks to flying the space shuttle twice a year through 2012?

Mr. BOLDEN. Yes, ma'am. There is—

Ms. KOSMAS. Besides the cost factor.

Mr. BOLDEN. No, no, no. There is a significant logistics issue, and once I fly the Launch on the Need vehicle, then the closest I can fly another vehicle is two years after that because I don't have tank sets that are prepared. So there would be a two-year gap between—

Ms. KOSMAS. So you suggest that that is a technical or logistical roadblock?

Mr. BOLDEN. It is a logistical roadblock.

Ms. KOSMAS. All right. As was stated by my colleague, I don't want to be argumentative either, but I do believe that we have the ability to make something happen if we have the decision in place to make it happen.

#### MAINTAINING SPACE WORKFORCE

I want to go on to another question, which has to do with the workforce. In my area, as you know, Kennedy Space Center, the President was there, which we appreciated and he stated in his speech that the Administration's proposal would mean 2,500 more jobs than under the program of record for my community at the Space Coast in Florida, and despite repeated requests, we have not received any further and specific information related to the workforce and the skills that would be required that would be helpful to me at the Space Coast to properly plan for the transition, not me but me and the folks I am working with in the area to plan for transition. I know that there are efforts in the works to try to work with the Administration at the Cabinet level to implement

the \$40 million workforce and economic development initiative proposed by the President but again, we don't have any details as to the specifics of the jobs that are intended to be created and therefore we have no way to match skills with that workforce that we so desperately want to retain. Do you have any details on the transition strategy that would help me to look at that workforce transition?

Mr. BOLDEN. Congresswoman, at this point I don't. As I sat down, we were having the third meeting of the taskforce or a sub piece of it, and the types of information that you want will probably not be available before mid-July when the taskforce starts to look at the draft report that we are going to give to the President.

Ms. KOSMAS. Okay. Thank you. Do you plan to relocate DOD or other Federal projects to Florida? Are you looking at opportunities to do that?

Mr. BOLDEN. No, ma'am, and I don't think Secretary Gates would appreciate my intervening in his responsibility. I understand what you are saying.

Ms. KOSMAS. As part of the transition, however, working with—

Mr. BOLDEN. In fact, DOD—every secretariat has representation on the task force that is being chaired by Secretary Locke and me, so we are looking across the board trying to see what we can do for the Space Coast.

#### SAFETY RECORD OF COMMERCIAL PROVIDERS

Ms. KOSMAS. Okay. I think my time is about to expire, but I just wanted to ask you one question and it has to do with your reliance emphasis on commercial. We know that Falcon-9 is getting ready to undergo its first test launch, and of course we wish it success. There is a great deal of pressure on it. However, we should also remember that ULA has been flying reliably and safely from Florida 40 launches in 40 months. Do you agree that this represents a solid record upon which we could build a commercial capability for access to low-Earth orbit for crew and cargo from both a cost and schedule standpoint?

Mr. BOLDEN. I agree that it represents a potential source of provision of commercial access to low-Earth orbit.

Chairman GORDON. Thank you, Mr. Bolden, and Mr. Wu is recognized.

#### TIMELINE FOR COMMERCIAL ACCESS TO LEO

Mr. WU. Thank you very much, Mr. Chairman.

Administrator Bolden, I heard you say in answer to Mr. Smith's question that you expect the new vehicle to be flying three years after it is put out to bid.

Mr. BOLDEN. I made the statement that what the commercial providers have said to me is that once they get a contract, they will have a vehicle that can comply with the human rating standards and be ready to fly in three years. That is a—I just related a statement.

Mr. WU. Right, right, and that is a very, very important distinction, and I want to focus on that for a second. What is your confidence level that what they have said is accurate or true?

Mr. BOLDEN. Based on the fact that I told the President that I can do the same thing with an Orion vehicle that I would have ready three years from now, I think my confidence in their ability to do that is pretty good.

Mr. WU. And what is your basis for that belief?

Mr. BOLDEN. The basis for my belief is confidence in my workforce and confidence in the leadership of NASA that has worked this issue and has given me a draft timeline and schedule.

Mr. WU. Now, that is an existing workforce. Do the private companies which may bid have similar workforces in place today?

Mr. BOLDEN. Every private entity that may bid, to my knowledge, has a viable, existing workforce, whether it is Boeing or SpaceX.

Mr. WU. Which can match NASA's?

Mr. BOLDEN. My workforce is the commercial industry. That is my workforce.

Mr. WU. So do you—

Mr. BOLDEN. I mean, I have 18,000 civil servants in NASA and hundreds of thousands of employees for whom I am responsible but I don't write their check. They work for Boeing, Lockheed, ATK, Orbital, Sierra Nevada, all these companies that say they can continue to do what they have been doing for us for 50 years. I am just asking them to do it and not make me buy the vehicle, let me lease it from them. It is a different in—I just have to go back. It is a difference in acquisition strategy that I want to try. Is it risky? Yes.

Mr. WU. So it is the same workforce that will transpose over, if you will, to whichever private bidder ultimately wins the contract. If that is the case, how does the Administration make the case that this will be done for less money or any less money that Orion could be done?

Mr. BOLDEN. Because the private entities or the commercial entities are telling me that they have learned through the years ways to be more efficient in their operations. They have in place programs like LEAN and 6 Sigma and other kinds of programs that have proven to be effective in bringing down cost. That is the way they make money.

Mr. WU. Now, I am a little confused and maybe I didn't properly track the prior conversation about potential inefficiencies in the private sector. Can you reconcile that for me?

Mr. BOLDEN. My comment about inefficiencies in the private sector? Congressman, I would have to go back and review what I said. I don't recall saying that. Everything has inefficiencies in it. We are trying to drive those inefficiencies by programs like LEAN, you know, 6 Sigma and other programs. So you may be referring to where I said is it going to be perfect, no, because we don't know how to do that yet.

Mr. WU. Very good. Thank you very much, Mr. Bolden. I appreciate it. I yield back the balance of my time.

Chairman GORDON. Mr. Davis is recognized.

## CEDING U.S. PREEMINENCE

Mr. DAVIS. Mr. Chairman, thank you very much. I have a brief comment, and then I will yield to Ms. Giffords.

Thirty years ago, we endeavored, I think in, not in political visionary, but in the ideological politics, it has given us a debt increase of \$1 trillion dollars, over \$12 trillion today. I look at the Gulf of Mexico, and I, it makes me feel like I live in a Third World country, when we cannot stop oil from oozing out into the Gulf.

John Kennedy said we will send a man to the Moon and return him safely by the end of this decade. We had a decade to plan to go to the Moon, and we came back. I want to know your plans, you don't have to answer my question, I want to know the plans of NASA. How are we going to have a manned vehicle that will guarantee America will not be in a Third World category in space flight? That is all I am asking, and I will support the program.

I yield to Ms. Giffords.

## CONSTELLATION PROGRAM DIRECTOR REASSIGNMENT

Ms. GIFFORDS. Thank you, Mr. Davis, Mr. Chair, Administrator Bolden.

Recently, we just received word that the Constellation program manager was removed from his position. Is that correct?

Mr. BOLDEN. That is probably correct, ma'am.

Ms. GIFFORDS. Well, you would know. It is a pretty important position.

Mr. BOLDEN. Well, I did not, it was not an action that I took or directed. It would be an action that would be taken by the Exploration Mission Directorate head, Doug Cooke, and the Johnson Space Center Director, Mike Coats. I have been in consultation with them about that, but, and my understanding was that they were going to get together with him this morning.

Ms. GIFFORDS. Mr. Bolden, my concern is, you know, particularly considering the news that we had last week, that the Program Manager was actually working hard to try to make the program work, given the constraints of the budget. But again, from where we sit, you know, his work to restructure and potentially save the parts of Constellation that need to be saved. By removing him from his position, I think it, again, it demonstrates to us that the question I asked you earlier, whether or not you would give this committee your assurance that you were doing everything that you can, as the NASA Administrator, to make progress with Constellation for the remainder of the fiscal year 2010, when the Constellation manager is removed from his position, it frankly makes me personally very dubious that that is, in fact, happening.

So, you know, I am just, I am wondering, you know, again, the assurance that you can give to us in the United States Congress, that you are actually carrying this out, and whether or not the program will carry forward, and whether or not you were planning on replacing him with someone who is competent, and replacing him with someone expeditiously.

Mr. BOLDEN. We would replace him with someone who is incredibly competent. I don't think I have anyone in the, you know, in the hierarchy of the Constellation Program or anywhere, that is not

competent and has my confidence. And Jeff Hanley is not leaving NASA. Jeff Hanley is moving up to become the Deputy Director of the Johnson Space Center for Strategic Studies and Strategic Plans. He is an incredibly talented individual, and you know, Jeff and I have spoken for quite some time, since I became the NASA Administrator, about his future.

Mr. DAVIS. Thank you, Mr. Bolden. And——

Ms. GIFFORDS. Thank you, Mr. Chairman. And again, because we have this very complex program, that demands a tremendous amount of oversight and management, again, it is of great concern to us that you take the manager out of his position and reassign him to another position. And I just want to let you know that I am very concerned by that.

Chairman GORDON. Mr. Hill is recognized.

Mr. HILL. Thank you, Mr. Chairman. Thank you, Mr. Bolden, for being here.

I think by and large, most of us, or a lot of us believe that the image of NASA has been a success program. I mean, our second panel today is going to be, consist of men who have walked on the Moon. That is pretty impressive. And so, in the last, you know, 50 years or so, we have been very proud of the American efforts in outer space. And it has become a very patriotic thing.

#### BENEFITS OF NEW BUDGET

Now, you mentioned a few minutes ago that what you are wanting to do is risky. And of course, there is no risk, there is no rewards. Convince us, because I think a lot of us are skeptical. Even as we have listened to your testimony today, that the rewards to be derived because of this risky thing that you are talking about doing, can you tell us what those rewards are going to be?

Mr. BOLDEN. Sir, it is going to be maintenance of American pre-eminence in space, continuance of our leadership as the acknowledged leader in human space flight and exploration.

Mr. HILL. Well, I guess that is an answer. Perhaps a little bit simplistic. Why do you believe that we cannot do that under the present program?

Mr. BOLDEN. Because it is unaffordable.

Mr. HILL. And what you are wanting to do is affordable.

Mr. BOLDEN. As I promised the chairman, I am going to bring him a budget and a program that will fit under a \$19 billion budget for 2011, or I won't bring him a program. And I am going to bring that to him, to this committee.

Mr. HILL. Okay. Thank you.

Chairman GORDON. And Ms. Edwards is recognized.

Ms. EDWARDS. Thank you, Mr. Chairman, and thank you for your testimony, Administrator Bolden.

#### TERMINATION LIABILITY

I just want to go back to the termination liability, and I know we have been over this, but a couple of things really just don't make sense to me. One is that the, these letters were asking for termination costs were sent, basically seven, eight months into the fiscal year. And that would mean about three quarters of the budg-

et had been spent for that year, and so, you put the contractors in a position of being almost three quarters into a fiscal year, and then having to make adjustments to accommodate having to preserve the termination liability costs within their current contracts.

How again is that fair to them, and didn't they have the benefit of a bargain at the outset, if that was going to be the requirement at the beginning of the year, to know that, so that they could accommodate their personnel and other costs accordingly? What I worry about is, so, for example, at one company, there is a young professional who is going to lose from the Constellation Program, is a 25 year old aerospace engineer, a graduate from the University of Michigan, transferred across the country to work on the program a year ago. And made the transfer, because he wanted to work on vehicles that would carry humans into low Earth orbit. Another young professional, a young Hispanic woman, a graduate from the University of Texas, degree in mechanical engineering, supported the program for two years, and she is assessing requirements and supporting development of test articles.

These people and their capacity will be lost, because the only way for the contractors to whom you have sent these letters, the only choice that they have, really, is to let people go, because for them to eat the costs of, you know, a couple of hundred million dollars, on the off chance that somehow, they are going to end up competing successfully in commercial competition, and retain their talented workforce, I just think that is too much to expect of these contractors.

We are going to lose these people. We are not going to lose them for a year or two years, or whatever it is down the line, when the competition finally comes into being and hiring starts. We will lose them permanently, because they will be off doing something else, someplace else. They may be in some other international space program, working, because they can't find that kind of work here. And so, or in some other sector of the industry entirely.

And so, my concern is that it seems to me that you are operating really, one, outside of your authority. I mean, this Congress could not have been clearer in saying to the Administration, all breaks, hold, while we figure this out together. And the Administration, it seems to me, is going its own direction, irrespective of what the United States Congress wants, and that is just not acceptable.

I want to add into the record a letter from Senator Mikulski to Peter Orzag, asking specifically about this, expecting a response, my understanding is by May 25. This committee deserves a response as well, because I think that the burden that you have now placed on your contractors is tremendous and cannot be met reasonably without, you know, at a time when we are actually struggling to create jobs in this country, and we are sending out these termination liability letters that inevitably result in the loss of highly skilled workers, a workforce that is completely demoralized. I mean, I am demoralized just looking at it.

And I don't think that is really acceptable for the Administration that says that it cares about science and technology and research in the Twenty First Century. And if we are going to say to these young people like I described, sorry folks, go find something else to do for a couple of years, while we just figure it out, we will lose

them. We will lose talent. This workforce will lose talent, and the United States will lose its preeminence, and I think that, I know I, for one, on this committee, don't intend to stand for it.

And so, I look forward to a response from the Administration to Senator Mikulski's letter about these terminations, and I fully expect that NASA is going to comply with the law, and with the direction from this Congress to stop it. And I don't know that it can be said in any other plain language than that.

Thank you very much.

Chairman GORDON. Thank you, Ms. Edwards. And as our second panel starts to move along, Mr. Bishop, if you have one quick question, we will let you go for it.

#### COST ESTIMATES FOR ARES PROGRAM

Mr. BISHOP. Thank you, Mr. Chairman. I appreciate your courtesy, and even the ranking member, your fairness in this process. I appreciate that. I had just a couple of quick questions from—

Chairman GORDON. You got one quick question here. And we got to get on to the next panel, sorry.

Mr. BISHOP. Okay. Let me go with the one quick question from General Bolden. And we have got to quit meeting like this, but there is only one way that is going to happen.

There is almost an urban legend coming out of NASA and from press clippings as to the cost of the Ares rocket. You have received a letter from one of your fellow travelers, Charlie Precourt, that challenges that number, saying the actual cost is about half of what you are talking about, and subsequent flights would be in the range of \$60 million.

The question I have is, have you seen that letter, a response to it, and also, were you, when you came up with your calculations, realizing that in the Defense Authorization bill, the language will state that defense officials have estimated that the cost of propulsion systems could increase 40 to 100 percent because of infrastructure costs currently shared by the Department of Defense and NASA, and they would be passed on to the Department of Defense.

Finally, the committee believes that the health and long-term viability of the solid rocket motor industrial base is a government-wide challenge. Am I correct on the assumption that the potential cost to Defense by the change in the program that NASA is recommending was not part of the original cost estimates for what Ares, Ares I or Ares V would be?

So, have you seen the letter?

Mr. BOLDEN. I think I have seen the letter to which you refer, from Charlie Precourt.

Mr. BISHOP. Has there been a response to his analysis?

Mr. BOLDEN. I don't, I would have to find out, sir. I don't think we have responded to his letter yet. But I will—

Mr. BISHOP. Was cost to the Defense system that will be shared by taxpayers part of the original analysis of costs for running Ares?

Mr. BOLDEN. Congressman, I will have to get back to you on that. I don't know the answer to that.

Mr. BISHOP. Can I help if I give you the answer?

Mr. BOLDEN. You can.

Mr. BISHOP. No. All right.

And with that, I do appreciate it. Some time, I just want to talk to you about this guy. This is the face of the people, who is celebrating his one week firing from this process, and I hope that at some time, I can tell him that the loss of his job was because either the government was going to save money, or come up with a program that was safer for astronauts, or it was in the public good, or the exigencies of the struggle, not simply because we decided to pick winners or losers within the free market system.

Chairman GORDON. Thank you, Mr. Bishop.

Mr. BISHOP. I appreciate it.

Chairman GORDON. And Mr. Bolden, thank you for your last two hours. We have enjoyed being with you. I hope you have enjoyed being with us.

Mr. BOLDEN. Congressman, I have. I appreciate it. I appreciate the opportunity to address this committee and hear your concerns.

Chairman GORDON. Well, you are going to get another opportunity.

Mr. BOLDEN. Yes, sir.

Chairman GORDON. And you are excused. And we will move now to our second panel.

Mr. BOLDEN. Thank you, sir.

Chairman GORDON. Our second panel has arrived, and I thank you for your patience. And I am sure you have had an opportunity to hear the earlier.

So, at this time, I will introduce our witnesses. First of all is Mr. Neil Armstrong, who really needs no introduction to anyone in this room. Was the commander of the Apollo 11 mission, and was the first person ever to set foot on the Moon. He also has a distinction, a distinguished career as an engineer, test pilot, professor, and is Vice President, or Vice Chairman of the Presidential Commission on the Space Shuttle Challenger accident.

Next is Captain Eugene Cernan, who was the commander of Apollo 17 mission, and the last person to visit the Moon, almost 38 years ago—was it 38 years ago?—in 1972. He had a distinguished career at NASA, and also has had a significant leadership experience in the commercial sector.

And finally, Mr. A. Thomas Young, who was the Executive Vice President of Lockheed Martin corporation, former President of Martin Marietta. Mr. Young has provided significant service to the Nation over the years, by leading independent reviews of major civil and military space programs, including most recently, the NPOESS Program. What a mess that was. We could do, if we could have that money back, we could do all these things.

He has been an invaluable resource for this committee, and we look forward to hearing his testimony today.

So welcome, and Mr. Armstrong, you may proceed.

#### **STATEMENTS OF NEIL ARMSTRONG, COMMANDER, APOLLO 11**

Mr. ARMSTRONG. Thank you, Mr. Chairman and members. I very much appreciate your invitation to allow me to present my assessments of the new NASA plan based on the President's 2011 budget submittal.

If one of the goals of government is to motivate its citizenry, and to be the best it can be, few government agencies will surpass

NASA in that function. I have met countless now middle-aged adults who credit NASA's human space programs for inspiring them to study hard in order to master and excel in their chosen field. And they are not just in aerospace, but in education, and astronomy, and computer science, and engineering, and medicine.

Some question why America should return to the Moon. After all, they say, we have already been there. I find that mystifying. It is as if 16th century monarchs proclaimed that we need not go to the New World. We have already been there. Or if President Thomas Jefferson announced in 1808 that Americans not need, need not go west of the Mississippi, because Lewis and Clark have already been there.

Americans have visited and examined six locations on Luna, varying in size from a suburban lot to a small township. That leaves more than 14 million square miles yet to be explored. And there is much to be learned on Luna. Learning to survive in the lunar environment, investigating many science opportunities, determining the practicality of extracting helium-3 from the lunar regolith, prospecting for platinum group metals, meeting challenges not yet identified.

The lunar vicinity is an exceptional location to learn about traveling to different, difficult, distant places. Largely removed from Earth gravity and Earth's magnetosphere, it provides many of the challenges of flying far from Earth. But communication delays with Earth are less than two seconds, permitting mission control on Earth to play an important and timely role in flight operations.

In the case of severe emergencies, such as Jim Lovell's Apollo 13, Earth is only three days travel time away. The long communication delays to destinations beyond the Moon may mandate new techniques and procedures for spacecraft operations. Mission control cannot provide a Mars crew their normal helpful advice if the landing trajectory is nine minutes long, but the time delay of radar, communications, and telemetry back to Earth is 19 minutes.

Flight experience at lunar distance can provide valuable insights into practical solutions for handling such challenges. I am persuaded that a return to the Moon would be a most productive path to expanding the human presence in the Solar System.

Mr. Chairman, you asked that I present my priorities for the human space program, and I suggest that first, we maintain American leadership. Second, we guarantee American access to space. And third, we continue to explore the Solar System. Leadership, access, exploration. Those are my priorities.

The issue facing this meeting has produced substantial turmoil among space advocates, so many normally knowledgeable people were completely astounded by the President's proposal. Had the announcement been preceded by a more typical review, analysis, and discussion among the executive branch, the agency, this Congress, and all the other interested and knowledgeable parties, no Member of this Committee would have been surprised by the announcement of a new plan.

In this case, a normally collegial sector of society was split in many fragments. Some focused on contracts and money, some on workforce and jobs, some on technical choices. All because a few planners, with little or no space operations experience, attempted

an end-run on the normal planning process. And it has been painful to watch.

Mr. Chairman, I sincerely hope that the Members of this Committee, and all others involved in this process, will work openly together to provide a plan which will be the best choice for our country.

Thank you.

[The prepared statement of Mr. Armstrong follows:]

PREPARED STATEMENT OF NEIL ARMSTRONG

Mr. Chairman and Members, I appreciate your invitation to present my assessments on the new NASA plan based on the President's 2011 Budget Submittal.

I am, admittedly, an aerospace enthusiast, having spent 17 years at NASA and its predecessor agency, NACA, prior to joining a university faculty to teach aerospace engineering. I was a member of the National Commission on Space and Vice Chairman of the Presidential Commission on the Space Shuttle Challenger Accident. I finished my active career in a company manufacturing a wide variety of highly engineered aerospace products and, more recently, served on the NASA Advisory Council. I still get excited about great new ideas.

If one of the goals of government is to motivate its citizenry to 'be the best that they can be', few government agencies will surpass NASA in that function. I have met countless now middle aged adults who credit NASA's human space programs for inspiring them to study hard in order to master and excel in their chosen field. And they are not just in aerospace, but in education, astronomy, computer science, medicine, and engineering.

The motivating quality of NASA programs and people is, I believe, due to its success in achieving leadership status in space travel and exploration, and to its enduring tenacity in exploring the frontiers of the cosmos. That is one reason why maintaining that leadership position is so important to our country. But it is certainly not the only reason. Success in expanding our understanding of the universe that surrounds us, and sharing that information with others around the globe, engenders respect and admiration from people and governments around the world. Discoveries and developments at technology's edge produce new theories, new products, new systems, and ultimately, new ways of living. Who, at the time of Sputnik, would have suspected that, two generations later, golfers would be determining their distance to the flagstick using a Satellite based GPS? Or that we could measure the rate at which the moon is moving away from Earth (currently about 1.5 inches/year)?

Management gurus have written endless analyses of push versus pull strategies. The applications are ubiquitous: marketing, advertising, manufacturing, development, etc. The new NASA plan includes technology push funding for research and the hope of 'breakthroughs' to hasten our success in developing craft to carry humans to distant cosmic destinations. Some have compared this approach to that of the National Advisory Committee for Aeronautics (NACA), the predecessor of NASA, whose only work was research and only product was reports. Some have assumed that NACA was completely a technology push agency.

As one of the small and ever diminishing number of NACA alumni, I can confirm that NACA did, in fact, conduct some technology push projects, such as the NACA airfoil series, the NACA engine cowl and supersonic boundary layer heat transfer. On the other hand, most research efforts were 'pull' projects, identified by the aeronautical industry and the military as problems that required solutions, and NACA help was requested. Examples are stability requirements for aircraft at supersonic speeds, understanding and solutions for transonic 'tuck', pitch-up, and roll coupling, practical variable sweep wings, and supersonic drogue chute development.

That work was exciting and fascinating. It was, day by day, perhaps the most genuinely satisfying work of my life. But it was not motivating to the general public. Rarely was the general public even aware of the remarkable research work that was going on in the NACA laboratories and flight tests. My experience in both pull and push operations leads me to conclude that pull research attached to an operational space exploration program would be substantially more likely to produce usable results in a timely manner.

Project selection and budgeting in the new NASA plan appears to have been heavily dependent on the observations and options presented in *Seeking a Human Spaceflight Program Worthy of a Great Nation* (HSP), familiarly known as the *Augustine Committee report*. It is interesting to review the constraints under which the

Augustine Committee operated, and the effects that those constraints imposed on their findings.

The committee was “asked to provide two options that fit within the 2010 budget profile” (HSP p. 15). The two options selected were the “Constellation Program of record” and the “ISS and Lunar Exploration”. The funding available for Constellation under the 2010 Presidential Budget Submittal was more than \$1.5 billion per year below the 2009 Budget and about \$3 billion per year below the original funding plan based on the Exploration Systems Architecture Study. The Committee quite properly concluded that the program would be delayed and cost more and Ares and Orion would be too late to serve the International Space Station, scheduled for termination in 2015. They found that “human exploration beyond low Earth orbit is not viable under the FY 2010 budget guideline” (HSP p. 96).

It is improper to conclude that Constellation was beyond help. Constellation managers believe they would have been in reasonable shape had NASA been provided the funding of the 2009 President’s Budget Submittal or even the 2011 Budget. Indeed, Mr. Augustine in his testimony to this committee last September said: “. . . we believe that the existing program, given adequate funds, is executable and would carry out its objectives.”

In determining the reasonableness of competing concepts to be compared, the Aerospace Corporation (Aerospace) was engaged by the Augustine Committee to provide estimates on cost and schedule. Your Subcommittee on Space and Aeronautics, thoughtfully, saw fit to ask Aerospace to provide details of that process.

Aerospace projected the development costs for a 4 person commercial spacecraft with launch abort system at 12 billion 2009 dollars plus \$8 billion for the launch rocket. Similarly, costs for a 6 person spacecraft would be \$17 billion (spacecraft + LAS) plus \$10 billion (launcher) respectively. The Committee assumed NASA would contribute 3 billion dollars to this project, which Aerospace, using historical growth and other factors, raised to 5 billion dollars (HSF, p. 70). The contribution remaining for the commercial provider is a very substantial investment and, if accurate, raises questions about the ability and willingness of a public or private company to accept that financial risk. Aerospace stated their assumption was that three competitors would bid and two would be selected. They further assumed that NASA would need two flights per year to the ISS. A reasonable business case supporting this proposal is elusive.

Some question why America should return to the moon. “After all”, they say, “we have already been there.” I find that mystifying. It would be as if 16th century monarchs proclaimed that “we need not go to the New World, we have already been there.” Or as if President Thomas Jefferson announced in 1808 that Americans “need not go west of the Mississippi, the Lewis and Clark expedition has already been there.”

Americans have visited and examined 6 locations on Luna, varying in size from a suburban lot to a small township. That leaves more than 14 million square miles yet to explore. There is much to be learned on Luna, learning to survive in the lunar environment, investigating many science opportunities, determining the practicality of extracting Helium 3 from the lunar regolith, prospecting for palladium group metals, and meeting challenges not yet identified.

The lunar vicinity is an exceptional location to learn about traveling to more distant places. Largely removed from Earth gravity, and Earth’s magnetosphere, it provides many of the challenges of flying far from Earth. But communication delays with Earth are less than 2 seconds permitting Mission Control on Earth to play an important and timely role in flight operations. In the case of a severe emergency, such as Jim Lovell’s Apollo 13, Earth is only 3 days travel time away.

Learning how to fly to, and remain at, Earth-Moon Lagrangian points would be a superb precursor to flying to and remaining at, the much farther distant Earth-Sun Lagrangian points.

And flying to further away destinations from lunar orbit or Lunar Lagrangian points could have substantial advantages in flight time and/or propellant requirements as compared with departures from Earth orbit. And flying in the lunar vicinity would typically provide lower radiation exposures than those expected in interplanetary flight.

The long communication delays to destinations beyond the moon mandate new techniques and procedures for spacecraft operations. Mission Control cannot provide a Mars crew their normal helpful advice if the landing trajectory is 9 minutes long but the time delay of the radar, communication and telemetry back to Earth is 19 minutes. Flight experience at lunar distance can provide valuable insights into practical solutions for handling such challenges. I am persuaded that a return to the moon would be the most productive path to expanding the human presence in the Solar System.

Mr. Chairman, you asked that I present my priorities for the human space program. I suggest that:

- 1) We maintain American leadership
- 2) We guarantee American access
- 3) We continue to explore the Solar System

Leadership, access, and exploration are my priorities.

This issue facing this meeting has produced substantial turmoil among space advocates. So many normally knowledgeable people were completely astounded by the President's proposal. Had the announcement been preceded by the typical review, analysis and discussion among the Executive branch, the agency, the congress, and all the other interested and knowledgeable parties, no Member of this Committee would have been surprised by the announcement of a new plan.

In this case, a normally collegial sector of society was split in many fragments, some focused on contracts and money, some on work force and jobs, some on technical choices. All because a few planners, with little or no space operations experience, attempted an end run on the normal process. It has been painful to watch.

Mr. Chairman, I sincerely hope the members of this Committee, and all the others involved in this process, will work openly together to provide a plan which will be the best choice for our country.

Chairman GORDON. Thank you, Mr. Armstrong, and I hope you will be a part of that with us, as we have this transparency.

Mr. ARMSTRONG. Thank you, sir.

Chairman GORDON. Mr. Cernan is recognized. You want to hit your microphone.

**STATEMENTS OF CAPTAIN EUGENE A. CERNAN, USN (RET.),  
COMMANDER, APOLLO 17**

Captain CERNAN. Excuse me. Thank you, Mr. Chairman. I also sincerely appreciate the opportunity to express my personal views concerning the Administration's "game changing proposal for the future of America's role in human exploration of space."

In my written testimony, I have gone into significant detail in what I consider the most critical aspects of the President's proposal, so in the interest of time, I will focus primarily on those items that you had put in the invitation to be here today.

Several weeks ago, we became aware of the Administration's plan for our Nation's role in the future of space exploration. Neil Armstrong, Jim Lovell, and myself felt compelled to voice our concern, and did so in an opinion paper signed by the three of us. We spent a great deal of time writing and refining our document, choosing our words very, very carefully. Words such as "devastating," "slide to mediocrity," and "third-rate stature," so that the intent of our message would neither be misinterpreted nor our deep concern about the future direction of human space flight as outlined in the President's proposal, be misunderstood.

We particularly wanted to avoid any political overtones, because since its beginning, America's role in space has traditionally transcended political and partisan differences. We have recently heard a lot of eloquent verbiage about exploration of space, landing on an asteroid, circling Mars, and at some time in the future, perhaps even landing on the Red Planet.

There is talk about a decision yet to come of building a large booster, which might ultimately take us almost anywhere we want to go in the far reaches of the universe. There are, however, no details, no specific challenge, and no commitment as to where or, specifically, when this exploration might come to pass.

And when one comes to examine the details of the 2011 budget proposal, nowhere, nowhere can be found, not one penny, allocated to support space exploration. Yes, there has been much rhetoric about transformative technology, heavy lift propulsion research, robotic precursor missions, as well as other worthwhile endeavors in their own right. Yet nowhere do we find any mention of human exploration of space, and nowhere do we find a commitment in dollars to support this all important endeavor.

We, Neil Armstrong, Jim Lovell, and myself, have come to the unanimous conclusion that this budget proposal presents no challenges, has no focus, and is, in fact, a blueprint for a mission to nowhere. In this proposal budget, we find several billions of dollars allocated and allotted to developing commercial human access to low Earth orbit, based upon the assumption, the sole assumptions and claims by those competing for this exclusive contract, who say they can achieve this goal in a little bit more than three years, and do it for something less than \$5 billion.

Even the Administration has shown some concern over these claims, by admitting a willingness, if necessary, to subsidize commercial, the commercial enterprise, until it ultimately, whenever that may be, becomes successful, calculated by some to be as long as a decade or more, with costs raising by at least a factor of three.

This assumes they have the capability in hand to design, to build, to flight-test and develop, a man-rated, man-rated spacecraft and booster architecture meeting the stringent requirements for safety, along with the infrastructure that is required for such a venture.

While I strongly support the goals and ideals of commercial access to space, the folks who proposed such a limited architecture do not yet know what they don't know, and that can lead to dangerous and costly consequences.

Based upon my own personal background and experience, I submit to this committee and to the Congress of the United States, and I do support the view that it will take the private sector as long as ten years to access low Earth orbit safely and cost-effectively. A prominent Russian academician is quoted as saying: In order to bring a craft to the standard of quality and safety for piloted flight, the United States will be dependent upon Russia at least until 2020. Such a commercial venture, should such a commercial venture run into insurmountable technical problems, business venture concerns, or God forbid, a catastrophic failure, it would leave the United States without a fallback program, unable to access even low Earth orbit for some indeterminate time in the future.

And without an extension of the Space Shuttle on the front end and viable access to low Earth orbit on the far end, the gap, as we call it, the period when America would be grounded, could extend indefinitely.

The sole reliance on the commercial sector, without a concurrent or backup approach, could very well lead to the abandonment of our \$100 billion Space Station, \$100 billion and 25 year investment in the Space Station, a default on our commitments to our international partners, and will ultimately close the, cost the American taxpayer billions of unallocated dollars, and surely lengthen the

gap from Shuttle retirement until the day we can once again access low Earth orbit, leaving us hostage to foreign powers.

Is this one of the potential grand challenges of the 21st century? The United States, through NASA, has spent half a century learning what we didn't know, finding answers to questions we weren't smart enough to ask at the time, developing technology that was needed to meet a challenge, to get the job done.

We came from Alan Shepard's flight in 1961 to the Shuttle and Space Station today, with a side trip or two to the Moon along the way. The evolution of this learning process was not without its costs, not just in dollars, but in the lives of our friends and colleagues. It took the courage, the effort, the dedication, and the self-sacrifice of thousands of Americans to bring us this far this quickly. And although we paid dearly for our mistakes, it is a testimonial to their commitment, and to American ingenuity, that everyone who went to the Moon came home.

Therein is a lesson we cannot afford to ignore. Mr. Chairman, is this the NASA we want to transform? Constellation is an architecture that, over a five year period, has gone through several detailed reviews, and has been vetted by every government agency from the OMB to the DoD, and certainly by NASA, by every agency that has an ownership interest in a technical scientific budget, or other benefit to be derived from human space exploration.

In addition, an arsenal of the best engineers and scientists that you have to offer, Mr. Young, and management experts in the aerospace community added their knowledge and expertise to the review of the proposed Constellation architecture before it ever even was considered to be worthy of moving forward.

Constellation follows the von Braun model of the evolution of the Saturn V. We are in the development of the Ares V, or excuse me, we are in the development of the Ares I, is the embryo for the development of the heavy lift Ares V. The shared DNA, with commonality of critical components throughout, leads to greater cost effectiveness, a higher degree of confidence and safety, and provides the first elements of a heavy lift booster now.

It is not unlike the Boeing family of jetliners, where the technology built into the 787 evolved from that of the 707. Embedded in the Constellation architecture is a culture of a long range building block that can not only service the ISS, extend the life of the Hubble, meet other national security priorities in low Earth orbit, but additionally, can carry us back to the Moon and on to Mars.

In doing so, it makes use of existing hardware and facilities, while developing new technologies with a purpose, with a direction. Exploration is what drives technology innovation, not the reverse. It is unknown how much time and thought was put into the existing budget for 2011, or by whom the proposal was generated, but it is common knowledge that very few, if any of those government agencies referred to above were asked to participate. Nor, significant note, was the DoD or the engineering management expertise that exists throughout NASA today, with no transparency, no transparency, one can only conclude that this proposal was most likely formulated in haste by a very few within the Offices of Management and Budget, or the Science and Technology Policy, with alleged involvement of the NASA Deputy Administrator and, by his

own admission, with little or no support input from the NASA Administrator himself.

Neither did NASA Center Directors, nor senior NASA management throughout the agency, nor program managers have any input. If that is, indeed, the case, the originators quite likely were promoting their own agenda, rather than that of NASA and America's commitment to human space exploration. And effectively leads NASA to becoming nothing more than a research facility.

My personal belief is that this proposal, Mr. Chairman, is a travesty, which flows against the grain of over 200 years of our history, and today, against the will of the majority of Americans. The space program has never been an entitlement. It is an investment. It is an investment in the future, an investment in technology, in jobs, in international respect, in geopolitical leadership, and perhaps most importantly, which has been stated here very well by Neil, perhaps most importantly, the inspiration and the education of our youth.

Those best and brightest minds at NASA and throughout the multitudes of the private contractors, large and small, did not join the team to design windmills or to redesign gas pedals, but to live their dreams of once again taking us where no man has gone before.

If this budget proposal becomes the law of the land, these technicians, these engineers, scientists, and a generation removed from Apollo, yet re-inspired by the prospect of going back to the Moon and onto Mars, will be gone. Where, I don't know, but they will be gone.

In conclusion, Mr. Chairman, history has shown that America's human space flight program has, for over half a century, risen above, excuse me, above partisan differences. From Eisenhower to Kennedy, to the present day, the challenges and accomplishments of the past were those of a Nation, never a political party, nor of any individual agenda.

Those flags which fly today on the surface of the Moon are not blue flags and are not red flags. They are American flags. We are at a crossroad. If we abdicate our leadership in space today, not only is human space flight and space exploration at risk, but I believe the future of our country is at risk, and thus, the future of our children and our grandchildren, as well.

Now is the time, Mr. Chairman, for wiser heads, in the Congress of the United States, to prevail. Now is the time to overrule this Administration's pledge to mediocrity. Now is the time to be bold, to be innovative and wise in how we invest in the future of America. Now is the time to reestablish our Nation's commitment to excellence.

Thank you, Mr. Chairman, and the Members of this Committee, for allowing me to share my concern and my passion for the future of this country.

[The prepared statement of Captain Cernan follows:]

PREPARED STATEMENT OF EUGENE CERNAN

Thank you, Mr. Chairman, for giving me the opportunity today to express my personal views concerning The Administration's "game-changing" proposal for the future of America's role in Human Exploration in Space.

Some weeks ago when we became aware of The Administration's plan for our nation's role in the future of space exploration, Neil Armstrong, Jim Lovell and I felt compelled to voice our concern and did so in an opinion paper signed by the three of us. We spent a great deal of time writing and refining our document, choosing our words very carefully, words such as "devastating", "slide to mediocrity", and "third rate stature", so that the intent of our message would neither be *misinterpreted* nor would our deep concern about the future direction of human space flight as outlined in the President's proposal be *misunderstood*. We particularly wanted to avoid any political overtones because the support of America's role in space since its beginning has traditionally transcended partisan politics.

It was determined after the Columbia accident that NASA should return to its core values, focusing its resources once again on space *exploration* while continuing its space *exploitation* through the Space Shuttle support of the International Space Station (ISS) and other national priorities of Low Earth Orbit (LEO). The Congress supported such a focus with a near-unanimous bipartisan approval in both the 2005 and 2008 NASA Authorization Acts.

We have recently heard a lot of eloquent verbage about the *exploration* of space—landing on an asteroid, circling Mars, and at some time in the future perhaps landing on the Red Planet. There is talk about a decision yet to come of building a large booster which might ultimately take us almost anywhere we want to go into the far reaches of the universe. There are, however, no details, no specific challenge, and no commitment as to where or specifically when this exploration might come to pass. My personal definition of space *exploration*, in contrast to *exploitation*, is "going where no man has gone before, doing what has never been done before, doing what others couldn't do, wouldn't do, or perhaps were afraid to do."

And, when one examines details of the FY 2011 budget proposal, nowhere is there to be found one penny allocated to support space exploration. Yes, there has been much rhetoric on transformative technology, heavy lift propulsion research, robotic precursor missions, significant investment in commercial crew and cargo capabilities, pursuit of cross-cutting space technology capabilities, climate change research, aeronautics R&D, and education initiatives, all worthwhile endeavors in their own right. Yet nowhere do we find any mention of the Human Exploration of Space and nowhere do we find a commitment in dollars to support this all important national endeavor. We (Armstrong, Lovell and I) have come to the unanimous conclusion that this budget proposal presents no challenges, has no focus, and in fact is a blueprint for a *mission to "nowhere."*

In this proposed budget we find several billions of dollars allotted to developing commercial human access to low Earth orbit, based upon the assumptions and claims by those competing for this exclusive contract who say that they can achieve this goal in little more than three years, and that it can be done for something less than 5 billion dollars. Even The Administration has shown some concern over these claims by admitting a willingness to subsidize the commercial enterprise until it ultimately becomes successful, calculated by some to be as long as a decade or more with costs rising by a factor of three. (These are the same entrepreneurs who are well over a year late delivering the first unmanned cargo to LEO.) This assumes they have the capability in hand to design, build, flight test, and develop a manned spacecraft and booster architecture meeting the stringent requirements for safety along with the infrastructure required for such a venture. Infrastructure such as redesigning the requirements of mission control, developing and supporting training simulators, writing technical manuals for ground and crew training including all onboard procedures, developing the synergy between a worldwide tracking network and the uniqueness of a newly designed space vehicle along with an emergency recovery force standing by to handle this new space architecture. These are only a few of the development and support requirements necessary to put any new manned system into space. Although I strongly support the goals and ideals of commercial access to space, the folks who propose such a limited architecture "*do not yet know what they don't know*", and that can lead to dangerous and costly consequences. There are a myriad of technical challenges in their future yet to be overcome, perhaps of greatest importance are safety considerations which cannot be, nor will be, compromised as well as a business plan and investors that will have to be satisfied. For example, it took over a year and a half of review and redesign of the Apollo I hatch prior to ever getting Apollo 7 off the ground, before operational and safety requirements were fully satisfied.

Based upon my background and experience, I submit to this Committee and do support the view that it will take the private sector as long as ten years to access LEO safely and cost-effectively. A prominent Russian academician is quoted as saying in order to bring a craft to the standard of quality and safety for piloted flight, the United States will be dependent on Russia until at least 2020. The Aerospace

Corporation, although directed not to examine the data submitted on cost and schedule by the commercial sector, estimates an initial cost of 10–12 billion dollars, plus the added cost of modifications required to launch vehicle ground systems. Should such a commercial venture run into insurmountable technical problems, business venture concerns, or—*God forbid*—a catastrophic failure, it would leave the United States without a fallback program, unable to access even low Earth orbit for some indeterminate time in the future. Without an extension of the Shuttle on the front end and viable access to LEO on the far end, “the gap”, or the period of time when America is grounded, could very well be extended indefinitely.

The sole reliance on the commercial sector without a concurrent or back-up approach could very well lead to the abandonment of our 100 billion dollar, 25 year investment in the ISS, default on our commitments to international partners, and will ultimately cost the American taxpayer billions of unallocated dollars and surely lengthen “the gap” from Shuttle retirement until the day we can once again access low Earth orbit leaving our nation hostage to foreign powers. Moreover, for a variety of reasons, a “Going Out of Business” sign hanging on the door is always a possibility in any high dollar-high risk investment. *Is this one of our “Potential Grand Challenges” of the 21st century?*

The United States, through NASA, has spent a half-century learning what we didn’t know, finding answers to questions we weren’t smart enough to ask at the time, developing technology that was needed to meet the challenge and get the job done. We came from Alan Shepard’s flight in 1961 to the Shuttle and Space Station today with a side trip or two to the moon along the way. The evolution of this learning process was not without its cost—not just in dollars, but also in the lives of our friends and colleagues. It took the courage, effort, dedication and self-sacrifice of thousands of Americans who allowed us to come this far this quickly. And, although we paid dearly for our mistakes, it is a testimonial to their commitment and American ingenuity that everyone who went to the moon came home. Therein is a lesson we cannot afford to ignore. *Is this the NASA we want to transform?*

Additionally, The President’s proposal suggests we develop “game-changing” technology for the future. The technology we enjoy today, 40 years after Apollo, is technology that evolved from a purpose, from the acceptance of a challenge and from a commitment to a goal. It was technology with a focus, with a mission. To simply put the best and the brightest in a room and tell them to develop breakthrough technology that *could* or *might* or *may* be useful in the future is a naive proposition. *Exploration drives technology innovation—not the reverse.*

Also in the proposal is the *possibility* that *maybe*, at *some time*, *perhaps* as far down the road as 2015, the United States *might* decide to develop a heavy lift booster. This is a very vague proposition, one that will likely never be funded to fruition. Coincidentally, Constellation has a heavy lift booster, Ares V, not only on the drawing boards but in component test today. Do we need a decision in 2015 for one already made today?

A late addition to the Administration’s proposal, and one very obviously not well thought out, was a provision to build an “Orion Lite” spacecraft as a rescue vehicle on the ISS. Although we have never had need for a rescue vehicle, we have today under contract with Russia two Soyuz continuously stationed on the ISS capable of carrying as many as six people to safety should the need arise, with a provision for a third Soyuz were the crew complement ever to increase to as many as nine—which is highly unlikely. An “Orion Lite”, before it is qualified to transport human beings to safety from the ISS, certainly would have to be man-rated. To man-rate a spacecraft and its ride into orbit requires a great deal more than following a list of safety requirements and protocol instructions included in its development. The “Orion Lite” would have to go through an extensive development, test and evaluation phase before being qualified to carry humans. It sounds very similar to what the existing Ares I/Orion development proposal is all about and would most likely cost as much, and require the same amount of time to bring it to man-rated flight status, yet leave us with half the capability of a full up Orion.

Constellation itself is an architecture that over a five-year period has gone through several detailed reviews and has been vetted by every government agency from the OMB to the DOD, and certainly by NASA—by every agency that has an ownership interest in any technical, scientific, budget or benefit to be derived from Human Space Exploration. In addition, an arsenal of the best engineers, scientists and management experts in America’s aerospace community added their knowledge and expertise to the review of the proposed Constellation architecture before it ever became an official program worthy of consideration. Constellation follows the Von Braun model in the evolution of the Saturn V, wherein the development of the Ares I is the embryo for the development of the heavy-lift Ares V. This shared DNA, with commonality of critical components throughout, leads to greater cost effectiveness,

a higher degree of confidence and safety, and provides the first elements of a heavy lift booster. It is not unlike the Boeing family of jetliners wherein the technology built into the 787 evolved from that of the original 707.

Embedded in the Constellation architecture is the culture of a long-range building block that cannot only service the ISS, extend the life of the Hubble, meet other national priorities in LEO, but additionally can carry us back to the moon and on to Mars. In doing so, it makes use of existing hardware and facilities while developing new technologies with a purpose. Appropriately under the law, both Houses of the Congress of the United States with overwhelmingly bipartisan support, approved and agreed that Constellation should go forward.

In contrast to the five-year review of the overall Constellation architecture plus the carefully monitored program development, the Augustine Committee was required to provide their report in 90 days. The report contained several suggestions and alternatives to Constellation, few of which were included in the FY 2011 budget, but ultimately the Committee came to the conclusion that Constellation's architecture had been well managed and is indeed executable, providing it has the appropriate funding that had been denied for several years. Important to note is that the Committee was directed to base their conclusions and recommendations not on the FY 2009 budget, but rather on the FY 2010 budget from which tens of billions of dollars had already been removed between 2010 and 2020. Additionally, their conclusions were based upon a 2015, not 2020, life span for the ISS and did not take into account ongoing requirements for access to LEO at other inclinations. Naturally, the Augustine Committee concluded that Constellation was not doable within the constraints of The Administration's mandated guidelines and budget restrictions. Under these constraints, one might have expected the *conclusions to be predetermined*. More importantly, however, the funding proposed for FY 2011, if prudently administered, is more than adequate to continue the development of Constellation.

It is unknown how much time and thought was put into the existing budget proposal for FY 2011, or by whom this proposal was generated, but it is common knowledge that few if any of those government agencies referred to above were asked to participate, nor, of significant note, was the DOD or the engineering or management expertise that exists throughout NASA today. With no transparency, one can only conclude that this proposal was most likely formulated in haste by a very few within the Offices of Management and Budget (OMB) and Science and Technology Policy (OSTP), with the alleged involvement of the NASA Deputy Administrator, and by his own admission, with little or no input from the NASA Administrator himself. Neither did NASA's Center Directors, nor senior NASA management throughout the agency, nor program managers have any input. If that is indeed the case, the originators quite likely were promoting their own agenda rather than that of NASA and America's commitment to Human Space Exploration as directed by Congress in the Authorization Bills of 2005 and 2008.

With the submission of FY 2011 budget, The Administration and the originators of this proposal were either misinformed or showing extreme naivete, or I can only conclude, are willing to take accountability for a calculated plan to *dismantle* America's leadership in the world of Human Space Exploration resulting in NASA becoming nothing more than a research facility. In either case, I believe this proposal is a *travesty* which flows against the grain of over 200 years of our history and, today, against the will of the majority of Americans.

The space program has never been an entitlement, it's an investment in the future—an investment in technology, jobs, international respect and geo-political leadership, and perhaps most importantly in the inspiration and education of our youth. Those best and brightest minds at NASA and throughout the multitudes of private contractors, large and small, did not join the team to design windmills or redesign gas pedals, but to live their dreams of once again taking us where no man has gone before. If this budget proposal becomes the law of the land, these technicians, engineers, scientists, a generation removed from Apollo, yet re-inspired by the prospect of going back to the moon and on to Mars, will be gone—where I don't know—but gone.

America's human space flight program has for a half century risen above partisan differences from Eisenhower to Kennedy to the present day. The challenges and accomplishments of the past were those of a nation—never of a political party or of any individual agenda. Those flags that fly on the moon today are neither blue flags nor are they red flags—they are American Flags. We are at a cross road. If we abdicate our leadership in space today, not only is human spaceflight and space exploration at risk, but I believe the future of this country and thus the future of our children and grandchildren as well. Now is the time for wiser heads in the Congress of the United States to prevail. Now is the time to overrule this Administration's

*pledge to mediocrity.* Now is the time to be *bold, innovative and wise* in how we invest in the future of America. Now is the time to re-establish our nation's *commitment to excellence.*

Thank you Mr. Chairman and members of the Committee for this opportunity to share my concern and passion for that which means most—*the future of our country!*

Sincerely, and with respect,  
Eugene A. Cernan  
Commander, Apollo XVII

Chairman GORDON. Thank you, Captain. I think you are ready to suit up again. Mr. Young, you are recognized.

**STATEMENTS OF A. THOMAS YOUNG, LOCKHEED MARTIN  
(RET.)**

Mr. YOUNG. Chairman Gordon, Mr. Hall, and Committee members, I am pleased to have the opportunity to present my views on the proposed United States human space flight program.

My judgment is that implementation of the proposed human space flight program will be devastating to NASA, human space flight, and the United States space program. For five decades, the United States robotic and human exploration program had remarkable successes that have filled our books of knowledge, explored new worlds, enhanced our international reputation, and given pride and inspiration to our fellow Americans.

We have also had disappointing failures. We have developed a mission success methodology that maximizes the probability of success, a methodology that has evolved over the life of the space program, and continues to improve with the experience gained with the execution of each new project.

A hallmark of the methodology is the recognition that space flight is a one strike and you are out business. Thousands of individuals can do everything perfectly, and one human error can result in mission catastrophe. While minimizing human errors is certainly an objective, human errors cannot be totally eliminated. The challenge is to prevent a human error from becoming a mission failure. Experience has shown that this is accomplished by test as you fly, and fly as you test, in combination with independent review and analysis, appropriate technical and management debate, and experienced leadership. For five decades, we have invested billions of dollars and the expertise of our best and brightest in NASA and industry, to evolve our current mission success methodology.

NASA has the continuity of human space expertise that is unique in our country and competitive with the best that exists globally. Our space industry is second to none in the ability to implement complex projects. It is the marriage of NASA's continuity of expertise with the implementation capability of industry that results in our proven mission success methodology, which maximizes the probability of success.

The Space Shuttle and International Space Station are products of this methodology. The Air Force and the Aerospace Corporation, in combination with their industrial partners, used this methodology to produce the highly successful EELV. NASA's Jet Propulsion Laboratory uses this methodology in implementing the Challenge and Planetary Exploration Program. And I might add that

the video that you saw earlier is a product of this methodology being applied in the success that was demonstrated in the video.

A fundamental flaw in the proposed human space flight program is a commercial crew initiative which abandons the proven methodology I have described. NASA's role is reduced to defining safety requirements and general oversight. An argument for pursuing this new human space flight approach is that the proven methodology is too expensive.

The same rationale caused the Air Force and NASA to try similar approaches in the 1990s. The Air Force implemented a program called acquisition reform. System responsibility for national security space programs was ceded to industry. And Air Force and NRO project managers were told to step back, not to interfere, and let industry have total responsibility. Additionally, the Air Force and NRO essentially eliminated their systems engineering capabilities, since the responsibility would reside with industry.

The results were devastating, and the adverse impact is still with us today. Good project managers and program management personnel left, and an exceptional systems engineering capability was eliminated. Projects were a disaster, and the approach was judged by all to be a total failure.

Problems were not isolated to one project or to one company. The impact was systemic. As an example, Future Imagery Architecture, managed by Boeing, was canceled after the expenditure of about \$10 billion. SIBRS High [Space-based Infrared System High], managed by Lockheed Martin, has been referred to as "a case study in how not to execute a space program." National Polar-orbiting Operational Environmental Satellite System, managed by Northrop-Grumman, is a story that is still evolving.

On average, programs implemented using this approach resulted in half the intended program for twice the cost, and they were six years late, on average. NASA implemented a similar approach, called faster, better, cheaper. Mars '98 is the most significant example of this approach. Mars '98 was a total failure, with the loss of an orbiter, a lander, and two probes. The orbiter, managed by Lockheed Martin under contract to JPL, failed because of a confusion between metric and English units. This confusion resulted in errors large enough, during Mars orbit insertion, to cause the spacecraft to enter the atmosphere and be destroyed.

These same errors were prevalent during midcourse corrections implemented on the trip from Earth to Mars without a cause being determined. Had the JPL institutional navigation capability been applied to understand these midcourse errors, I believe they most likely would have found the cause, and implemented corrections to prevent the failure. They were excluded from the management of Mars '98 because of the give the contractor the responsibility concept. This is an example of how NASA's continuity of expertise could have been applied to an important and challenging project.

I cannot conceive that the United States will abandon a methodology developed over decades, with enormous human and financial investment, for a concept that has been tried in the 1990s, resulting in massive failure. Why would we put NASA human space flight at such risk by employing an unproven commercial crew concept?

Commercial crew is a risk too high. It is not a responsible course, and it should not be approved. Continuation of the international space program is an area of apparent consensus. A launch vehicle and crew capsule for transportation to and from the Space Station are required. I believe the most appropriate option is Ares I and Orion.

NASA should be directed to develop a plan for transporting humans to and from Earth orbit. Ares I and Orion elements of Constellation should not be canceled. The results of the NASA plan development may suggest changes to Constellation. A disappointing truth in the proposed NASA Fiscal Year 2011 budget, in my opinion, is not adequate to support a credible, implementable Space Station program and a credible, implementable beyond Earth orbit exploration program. A credible Space Station program without commercial crew needs to be defined. An exploration program with a heavy lift launch capability and exploration capsule, a focused technology program, and an exploration concept with destinations and dates also needs to be determined.

Cost estimates, with substantive, independent systems engineering, and end to end cost estimating need to be developed. Timely completion of these proposed actions is necessary to allow resolution of current human space flight uncertainties. Only then can credible decisions be made as to the future of human space flight.

In summary, do not approve commercial crew. Continue the Ares I and Orion programs. And do the necessary in depth analysis and study that was absent from the proposed Fiscal Year 2011 budget, to define the human exploration program worthy of a great Nation. Only then can the value of the program be judged against credible plans and budget.

Above all else, do not approve a human space flight program without adequate resources to assure success. We have traveled that road too many times with the same unsuccessful result.

Thank you.

[The prepared statement of Mr. Young follows:]

#### PREPARED STATEMENT OF A. THOMAS YOUNG

Chairman Gordon, Mr. Hall and Committee members, I am pleased to have the opportunity to present my views on the proposed U.S. human spaceflight program.

My judgment is that implementation of the proposed human spaceflight program will be devastating to NASA, human spaceflight and the U.S. space program. For five decades the U.S. robotic and human spaceflight programs have had remarkable successes that have filled our books of knowledge, explored new worlds, enhanced our international reputation and given pride and inspiration to our fellow Americans. We have also had disappointing failures.

We have developed a mission success methodology that maximizes the probability of success, a methodology that has evolved over the life of the space program and continues to improve with the experience gained with the execution of each new project. A hallmark of the methodology is the recognition that spaceflight is a "one-strike-and-you-are-out" business. Thousands of individuals can do everything perfectly and one human error can result in a mission catastrophe. While minimizing human errors is certainly an objective, human errors cannot be totally eliminated. The challenge is to prevent a human error from causing a mission failure. Experience has shown this is accomplished by test-as-you-fly and flying-as-you-test in combination with independent review and analysis, appropriate technical and management debate and experienced leadership. For five decades we have invested billions of dollars and the expertise of our best and brightest in NASA and industry to evolve our current mission success methodology. NASA has the continuity of human spaceflight expertise that is unique in our country and competitive with the best that exists globally. Our space industry is second to none in the ability to implement

complex projects. It is the marriage of NASA's continuity of expertise with the implementation capability of industry that results in our proven mission success methodology which maximizes the probability of success. Space Shuttle and International Space Station are products of this methodology. The Air Force and the Aerospace Corporation in combination with their industrial partners use this methodology to produce the highly successful EELV. NASA's Jet Propulsion Laboratory uses this methodology in implementing the challenging planetary exploration program.

A fundamental flaw in the proposed human spaceflight program is a commercial crew initiative which abandons the proven methodology I have described. NASA's role is reduced to defining safety requirements and general oversight. An argument for pursuing this new human spaceflight approach is that the proven methodology is too expensive.

This same rationale caused the Air Force and NASA to try similar approaches in the 1990s. The Air Force implemented a program called "Acquisition Reform." System responsibility for national security space programs was ceded to industry. Air Force and NRO project managers were told to step back, not to interfere and to let industry have total responsibility. Additionally, the Air Force and NRO essentially eliminated their systems engineering capabilities since the responsibility would reside with industry.

The results were devastating and the adverse impact is still with us today. Good project managers and project management personnel left and an exceptional systems engineering capability was eliminated. Projects were a disaster and the approach was judged by all to be a total failure.

Problems were not isolated to one project or to one company, the impact was systemic. As examples, FIA managed by Boeing was cancelled after the expenditure of about 10B\$. SIBRS High, managed by Lockheed Martin, has been referred to as "a case study in how not to execute a space program." NPOESS, managed by Northrop-Grumman, is a story that is still evolving. On average, programs implemented using this approach resulted in half the intended program for twice the cost and six were years late. NASA implemented a similar approach called "Faster-Better-Cheaper." Mars '98 is the most significant example of this approach. Mars '98 was a total failure with the loss of an orbiter, lander and two probes. The orbiter managed by Lockheed Martin, under contract to JPL, failed because of confusion between metric and English units. This confusion resulted in errors large enough during Mars orbit insertion to cause the spacecraft to enter the atmosphere and be destroyed. These same errors were prevalent during midcourse corrections implemented on the trip from Earth to Mars without a cause being determined. Had the JPL institutional navigation capability been applied to understand these midcourse errors, I believe they most likely would have found the cause and implemented corrections to prevent the failure. They were excluded from the management of Mars '98 because of the "give the contractor the responsibility" concept. This is an example of how NASA's continuity of expertise could have been applied to an important and challenging project.

I cannot conceive that the U.S. will abandon a methodology developed over decades with enormous human and financial investment for a concept that when tried in the 1990s resulted in massive failure. Why would we put NASA human spaceflight at such risk by employing an unproven commercial crew concept?

Commercial crew is a risk too high, not a responsible course and should not be approved.

Continuation of the International Space Station is an area of apparent consensus. A launch vehicle and crew capsule for transportation to and from the Space Station are required. I believe the most appropriate option is Ares 1 and Orion. NASA should be directed to develop a plan for transporting humans to and from Earth orbit. The Ares 1 and Orion elements of Constellation should not be cancelled. The results of the NASA plan development may suggest changes to Constellation.

A disappointing truth is the proposed NASA FY 2011 budget, in my opinion, is not adequate to support a credible, implementable Space Station Program and a credible, implementable beyond-Earth-orbit exploration program.

A credible Space Station program, without commercial crew, needs to be defined. An exploration program with a heavy lift launch capability, an exploration capsule, a focused technology program and an exploration concept with destinations and dates also needs to be determined. Cost estimates, with substantive independent systems engineering and independent cost assessment, need to be developed. Timely completion of these proposed actions is necessary to allow resolution of current human spaceflight uncertainties. Only then can credible decisions be made as to the future of human spaceflight.

In summary, do not approve commercial crew, continue the Ares 1 and Orion programs and do the necessary in depth analysis and study that was absent from the

proposed FY 2011 budget to define the human exploration program worthy of a great nation. Only then can the value of the program be judged against credible plans and budget. Above all else, do not approve a human spaceflight program without adequate resources to assure success. We have traveled that road too many times with the same unsuccessful result.

Chairman GORDON. Thank you, Mr. Young, for your usual bluntness. You got to the point there.

I know that this panel, and I am sorry you had to wait so long to come forth. I know you have some back end commitments, so we will be limited. So, I am going to yield my time to Mr. Wu.

#### DURABILITY OF PRIVATE SECTOR APPROACH

Mr. WU. Thank you very much, Mr. Chairman. I very much appreciate that.

We have a number of Members of this Committee who represent districts that have a lot of space activity, and quite frankly, they may be more knowledgeable than I, and they have a lot of questions to ask.

Oregon has very little, if any space activity. I think that is a shame. My interest, my very strong interest in this topic is driven by my concern for the future of technology in this Nation, and the future of American leadership.

My prior questions to Administrator Bolden brought forth some answers that the infrastructure currently used by NASA, the employees and so on, would be substantially transferred to the new effort, and I am concerned about whether that would be true or not, but for purposes of this question, if that is to occur, I have some, there is a significant doubt about what, where the cost savings would come from. Why would it be cheaper in the private sector?

Now, I have been in this town long enough to kind of see a political process, or a policy process play out, which is you have program number one, it runs into tough territory, whether for timing or cost purposes, so you cancel program number one, and you kick the can down the road, by saying we are going to start program number two, in this case, kick it to the private sector. And if, indeed, there are not cost savings to be had, I am concerned that a future Administration and a future Congress would be faced with the prospect of either canceling human space flight by Americans or paying the same kind of cost increases, or maybe larger, because it is further on down the line.

I would like to ask all three of you to comment on that concern about this potentially being a cancellation of American space flight in a two step process.

Mr. ARMSTRONG. Congressman Wu, I think that is an excellent point.

There is always difficulty when programs are extended, and the motivation and the intensity and the passion for the project disintegrates with time, and they become, at the time they exceed their budget by substantial amounts, and then the budgets are cut, then usually, the programs are redefined into a less aggressive program, and perhaps eventually into an R&D program, and then, each step along the way, they are more subject to cancellation. So,

it is kind of a self-fulfilling prophecy that such activities are swimming upstream.

Mr. WU. Mr. Armstrong, thank you. I have never been told by the first man to walk on the Moon that I have made an excellent point. Thank you. Captain Cernan.

Chairman GORDON. You might not be again, either, David.

Mr. WU. I will take that one. Captain.

Captain CERNAN. My feeling, in support of what Tom Young, and I know what Neil believes, in support of the Constellation program, is we should take it in steps and bounds, leading ultimately to what I am a guru on, is space exploration. That is where I want to go. I want to see us go to Mars.

But I think we first have to look at our problems today, and I think if we take a good, hard look, and review what Ares I, Constellation itself, and re-review it, perhaps, and figure out, can we really get airborne in 2015 or '16 or '17, and pick it. We know we can perform, and we know what funds we are going to have available. Hopefully, they will still be available. And say we can produce a program in 2015. We won't have to start, or 2016, we will have something that will access Earth orbit.

Of course, we have a problem in the front end, as I said, and that is Shuttle. Quite frankly, I happen to be one of those believers who said how can we terminate the most phenomenal, capable flying machine the world has ever seen, that we have ever designed, built, and flown, and it is just getting into its state of maturity, being able to do the job well, and obviously, extremely safely at this point in time, from what we have learned. How could we terminate that? We ought to extend into that period of time that we think Constellation will come on board, and take Shuttle out to 2015, if that is what is necessary.

Now, I don't have control of the funds, Mr. Chairman, so you know, I know there is a problem there. But to keep us in the space game, to keep us in the air, if you will, and then along the way, we can decide where we go from there with space exploration, the evolution of Ares V as it comes from the success of Ares I. And it is not, to me, it is not so important when we get there, but what is important is that we have, for future generations, a commitment. The direction we take is far more important, to me, than when we get there.

Chairman GORDON. Mr. Wu's time has expired, but Mr. Young, did you want to add something?

Mr. YOUNG. Yeah, I would like just to add a little bit.

First off, this is a people-intensive industry, enterprise, and if we save money in a particular area, you can only save money by eliminating people. I mean, that is where it comes from. And if, in our commercial crew focus, we fundamentally save the money that is talked about, we will eliminate NASA workforce, as well as some industry workforce. That workforce will never come back. You know, that will be gone forever.

So, there are a lot of consequences that need to be carefully thought about, as your question suggests, and I would offer that.

My only other comment is, early in my life, a previous NASA Administrator actually said to me: "Be cautious. That green grass sometimes is poison ivy."

Chairman GORDON. Thank you, Mr. Young. Mr. Hall is recognized.

#### RETURN TO THE MOON

Mr. HALL. Mr. Chairman, I won't take a lot of time. I am glad Lewis and Clark didn't stop at the Mississippi. Glad they went on to El Paso. I guess I am glad they went to Phoenix and maybe to well, I don't know about seeing the Pacific shore. That was on November 15, 1805, and my kids think I remember that day. But we wouldn't have had Rohrabacher if they hadn't gone on to the ocean-side, though, so we have got a lot to be thankful for.

I have one brief question here, and first, my opening statement, I adopt what all three of these gentlemen have said, every sentence, every dash, and every quote. It is the greatest testimony I have heard in the 30 years I have been up here, and I thank you for it.

I want to ask, if I might, from Mr. Armstrong. During the, his appearance at the Kennedy Space Center, I am sure you heard that, or have observed it. The President discounted the idea of going back to the Moon, and instead, spoke about going to other destinations, but from your perspective, if the goal is to take a stepping stone approach to deep space, as both of you, as each of you have alluded to, is the Moon a nice to have, or a need to have?

Mr. ARMSTRONG. It is both. It is both, sir. It is hard to explain that there are good reasons to return the Moon, from a variety of perspectives. And it is a wonderful place to learn the elements of deep space, space flight with. It is a relatively safe and convenient place that uses, is able to use the best of the technologies we have developed over the last four or five decades, and I think that it should, indeed, be included in our plans for deep space exploration.

Mr. HALL. Mr. Cernan, do you agree to that? Don't you? You have—

Captain CERNAN. Yes, sir. I adamantly agree with it, and there is a whole host of other good reasons we don't have time to talk about here today.

Mr. HALL. Well, like the Administrator, you can send me a copy of those, can't you? I thank all three of you. I yield back my time, Mr. Chairman.

Chairman GORDON. Governor Garamendi is recognized for five minutes.

#### CONSTELLATION LITE

Mr. GARAMENDI. Thank you very much. Captain Cernan, you talked about Ares I, a progressive program. I would like you to expand on that. In the testimony we heard earlier from the administrator, he said no, he is not even going to think about Constellation Lite, or some sort of a progressive program, but I would like to have you to expand on your vision on how that might proceed so that the administrator might be informed about the potential possibilities.

Captain CERNAN. Well as I understand it, the entire Constellation was programmed with the idea that it could be built upon, step by step, ultimately reaching for the Moon. The initial require-

ment was to get into Earth orbit. Initial requirement was to service the space station. Initial requirement was to have American access, not dependent upon foreign powers to get us back up there, as quickly as humanly can. Orion was developed not as, you know, this Orion Lite is a whole different ballgame, and that would cost just as much money and take as much time, I am sure, as a full up Orion. But Orion was designed to evolve from the same vehicle. You reconfigure the interior and so forth, the navigation system, what was required to mature into a deep space vehicle from—one that could go into low Earth orbit. The Ares I was designed, and has been tested—the component testing on the Ares I, the solids that have already been tested on the first Ares I test flight, are part of the Ares V. The J-2X engine, by the way, is an upgrade, as best I understand it, from the J-2 that we used to go to the Moon. So it—we know what kind of hardware we are dealing with. We know what kind of facilities we got. The facilities that are being—already being set up on Pad B down at Kennedy are facilities that can support Orion and be—correction, Ares I and be upgraded to support the larger Ares V vehicle. So it is a—there is an inherent culture in Constellation to take us from Earth orbit to the Moon, or to asteroids, or to Mars, or to anywhere we want to go.

#### SPACE SHUTTLE EXTENSION

Mr. GARAMENDI. I thank you for that. I assume that the men and women that are working for the administrator understand, or heard what you said. If not, I am sure they will get a tape of that. Secondly, you talked about the interim period before the Constellation Ares program is capable of delivering supplies to the Space Station. I think that really needs to be explored and expanded. I couldn't agree with you more, with regard to the shuttles and their longevity. Your use of the maturing is a valuable word, I think, for most of us here who have reached that point. If you could expand on that just a bit in the two minutes that I have left?

Captain CERNAN. Mature means you know a lot more than you used to know, I guess, and that is—we know—

Mr. GARAMENDI. You are wiser about those things—

Captain CERNAN. You know, we have been through some tragic catastrophes with Shuttle. We have learned something. As I said, we spent 50 years learning that which we didn't even—weren't even smart enough to ask the questions about. But it—the shuttle was designed for 100 flights, with a factor of—safety factor of four. And I don't know the exact number on the shuttle vehicles—the three shuttle vehicles left, but I know it is down in the 20s and 30s right now. So we have a fleet—we have the only real capability to get into Earth orbit. And compared to the Soviets and what the Chinese are putting in orbit, they don't hold a candle to what the shuttle can do. And why in the world do we want to just quit? Not only—if we had something sitting on the pad ready to take its place, that is one thing, but we don't. We are abdicating our role in space. We are abdicating our capability to go to the space station by not being able to get there. And commercial space is not going to get there I mean, I—give me ten years, and I want to see them mature, and then they can take over the program, but not until then. And I am not going to be around. What I am worried about

is what happens in the near future. So I think we have got to close that gap with the shuttle, and the only way—it is just not extending out the flights. We have got to get some more shuttle flights. We have got to keep this thing flying—2015. Pick out a date. Pick out a date when you think Ares is going to be ready to take over.

Mr. GARAMENDI. Captain, thank you very much for your knowledge and your passion, and I think Mr. Young would agree with at least part of what you said, if not all of what you said about—wait a minute, commercial has a history also, and not a good one. Thank you very much.

Captain CERNAN. Thank you, sir.

Chairman GORDON. Dr. Ehlers is recognized for five minutes.

#### NASA PRIORITIES

Mr. EHLERS. Thank you, Mr. Chairman, and thank you, gentlemen, for being here. I listen with extreme interest because of the many times we have had hearings, we have rarely had people who had the conviction that you had, and also the background that you had. I might add that I am a scientist. I was horrified to be reminded once again about the error with the metric system and the English system. I tried to introduce a bill immediately after that happened to require the metric system on everything that NASA did. I was promised by the then administrator of NASA that if I would withdraw the bill he would take care of it, and, of course, didn't. So we are very slow to learn. That is just a side issue at this point. What I am really interested in is your—the reference made, repeated by each of you, is the need for exploration. And I happen to agree with that, as a scientist. We have much more to explore. I am not—it is not quite clear to me why—how we are to pick the topics to be explored. Clearly the moon is still of interest. Mars is of even greater interest, but extremely difficult, unless we find enough volunteers who want to make a one way trip. But the difficulty of landing, replenishing the fuel supply and coming back is very formidable. I am not saying it is impossible, but very formidable. But what—I guess I am most interested in the process. You know, I have never been involved in an experiment where we didn't know precisely ahead of time how we were going to proceed, what we were searching for, what we were exploring for. It is not that we didn't find surprises along the way, but you really have to decide very clearly ahead of time what you are trying to achieve. And that, to me, is what has been lacking here, and I appreciate, Mr. Armstrong, your delineation of why it is important to go to the moon. It is sad to say that that is the first time I really heard a good explanation from the hearing table about that point. So—I—it, you know, maybe one answer is to have a president who is a scientist. That would probably help. But—and I am not applying for the job, although I am in the process of trying to renew my pilot's license, so maybe I can work on the other end. The—what are we really trying to achieve, and—I—can you give me any clarification, any one of you? What are we trying to explore? What are we trying to achieve? What do we hope to get out of it? And I recognize you can't predict these things in advance, but I wonder if you could

just quickly each run through what you would say in response to that question if the president called you in and asked you.

Mr. ARMSTRONG. Thank you. First, exploration is the principle ingredient in the charter of NASA.

Mr. EHLERS. Yeah.

Mr. ARMSTRONG. Because I was—I remember because I was one of the few people around that was in NASA on its first day after the Act was passed. And as I said in responding to the Chairman's question, my priorities were leadership first, access second, and third, exploration. Leadership, I think, is critically important because it affects our nation, and—in so many ways. It affects the viewpoint of others—other citizens and other countries around the world about our country in a very meaningful way. I would just give one example, if I might? We were—Gene, Jim Lovell and myself were in a Mideast trip a couple of months ago, thanking the troops for their service, and while at Incirlik Base in Turkey, near the Syrian border, the State Department requested that we go over and visit a local university named Cukurova, the third largest university in Turkey, one that had continued to have been requesting information on NASA's space program but never had been able to get a speaker. So we were in the area, and they shanghaied us into that job. Unfortunately, the timing was imperfect. Two days before that resolution on the genocide matter of Turkey of a century ago was passed, and the day before we arrived, the Turkish ambassador was recalled to Turkey, and so now we are going into a big presentation with all the press looking at us, expecting us to explain this international crisis, from their point of view. As it happened, our welcome was remarkable. There were probably four or five times as many people came to hear our presentation than they had seats in the auditorium. They set up loudspeakers outside so they could hear. They gave us a marvelous welcome, warm reception, and asked a lot of questions, so rigorously that the journalists there never could ask—have the opportunity to ask their questions about the international disagreement. I would just point out that—by way of explaining, from the point of view of a foreign national, this—what we do in space seems to be far more important to them than that it is—than matters about international differences. It just illustrates the importance of leadership. My second point was access, and, of course, we can't do anything in space without access. That is why the second point was what it was. And third was exploration, because our business is getting out to the boundaries of human knowledge and finding out new things which will inspire people to believe that the human race can do more than it is now doing, and they can do it better. And it will be important—it—not only to our own citizens, but to people around the world, and for that reason I pick exploration without saying specifically what, and in what order. Exploration, by nature, is what we should be doing.

Chairman GORDON. Dr. Ehlers's time has expired, and Ms. Edwards is recognized.

#### NASA TECHNICAL CAPACITY

Ms. EDWARDS. Thank you, Mr. Chairman, and thank you, gentlemen. It is so wonderful to see you here today. I mean, you, both in your testimony and in your life's work, just really continue to

inspire me, and I think inspire this nation, and really are the best reflection of why it is that we make an investment in space. Not for what we know today, but what we might know tomorrow. I was just thinking back that—I know when I was in grade school, watching that black and white television, I thought then that a geek with glasses, horrible eyesight, that I could actually be an astronaut. Never happened, but I do think it speaks to the role that the agency and the work that goes on has played in inspiring young people to do all kinds of things that really don't have any—may not have anything to do with space. I wanted to focus particularly on a part of your testimony, Mr. Young, in which you say it is the marriage of NASA's continuity of expertise with the implementation capability of industry that results in our proven mission success methodology, which maximizes the probability of success. And the reason is because my recollection in my work at Goddard Space Flight Center is that, as skilled and capable engineers, systems engineers, software engineers, hardware engineers, internal to NASA, there were partners in—on the private sector side. And it was because of that kind of relationship and partnership and expertise internal to NASA that enabled, I think, our work to proceed in a much more professional and scientific way. And so I wonder if you would comment about what it means to NASA's internal capacity and expertise when you shunt the bulk—all—virtually all of the human space flight capacity to the commercial sector? Because, in my view, NASA's always worked alongside private industry, the question is what kind of relationship has there been between the agency and its contractor community with that internal expertise? And so I wonder if you would comment about what that will mean on—in the long run to NASA's internal technical and scientific capacity?

Mr. YOUNG. That is really a very thoughtful question. Let me comment. As you describe, we really have learned how to do these things. Not without risk, and not without an occasional failure, but we basically know how to do them. And we do them by integrating just an extraordinary capability, both in the government, or NASA, side and the—and in the industry side. If we decide what we are going to do is cede all of this responsibility basically to industry—and this is not a—industry. It is just that they don't have the—what I call continuity of expertise capability that I am describing in NASA. What will happen, in my view, is the good people in NASA, and there really are good people, they are not going to be satisfied with sitting in the back of the room and not, you know, asking questions, or not participating. NASA's a value added organization. When I was a young engineer, it is why I went, because I could contribute when—it—was my belief. So good people are not going to go do that, they are going to go look for other opportunities. The one thing that I really underline is good people always have a choice. I mean, they always have an opportunity choice, so good people will go to other organizations. That will kind of be the beginning of what I would say will be the atrophy—atrophying of the NASA workforce. I think that what will happen, if I take Gene Cernan's scenario, which I personally subscribe to, I don't know exactly, when, but we will find out what I believe to be the deficiencies in the commercial crew somewhere downstream. They will

manifest themselves either in some development failures, significant cost growth, significant delays, industry not willing to continue to invest, but they are in our future. Then, when we turn around for this workforce that you are talking about to bail us out, using that term, they won't be there. These good people will be off, I don't know doing exactly what, but they—you—this is not a capability that can respond to an off/on switch. I mean, we built this with a lot of investment, and so there are a lot of ramifications of the decisions that is facing you all, but one of which is the quality of this workforce as we go forward. And I don't think there is any question in my mind that, you know, if implemented as proposed, the workforce will atrophy to the point that we will not have the ability to come to the rescue when the rescue is called for.

Ms. EDWARDS. Thank you, gentlemen. And I know we don't have time for it now, but at some point it will be helpful for you all also to reflect on the lessons learned, as I recall them, from both Challenger and Columbia, with regard to NASA's internal capability of providing the kind of oversight that is needed to head off catastrophes like that. Thank you.

Chairman GORDON. Gentlelady's time has expired, and Mr. Rohrabacher is recognized for five minutes. Before Mr. Rohrabacher, let me say that I am being called to another committee, and I guess—I think Chairlady Giffords, who is the chairman of the space—are you able to—

Ms. GIFFORDS. Mr. Chair, I just have to leave in 30 minutes, so if the meeting is going to go over, we should have someone else carry the meeting.

Chairman GORDON. Okay. I think 30 minutes should—our friends on this panel have got to leave before that time anyway. So, with that, Mr.—and let me thank you very much. I know that you came here today not because it is fun, but because it was—you felt it was a part of your mission, and thank you for your—again, for your contribution, and for your patriotism.

Mr. ROHRABACHER. Mr. Chairman, before you leave, just one point I would like to make before you leave, because it concerns this hearing. This has been a great panel, and it has been a great hearing, but it is not—and—it has not been a balanced hearing. We have not received both sides of this issue at all from this presentation, and I would hope that before we go to an authorization that we would have a panel presented to us that could give both sides of the issue. And I am not complaining about their position at all, I am just saying there is another side—Rusty Schweickart was there.

Chairman GORDON. Uh-huh.

Mr. ROHRABACHER. Buzz Aldrin, other people who are expert in this area, and they have not been given their chance to present an alternate point of view. And I would hope, before we go to an authorization, that we could at least have—

Chairman GORDON. If the gentleman would yield, first of all, Mr. Bolden took two hours of—putting forth, you know, an opposition, or a different position. John Holdren was invited to enhance that. Unfortunately, he was not able to come. But you can be well assured that we are not one hearing away from an authorization.

Mr. ROHRABACHER. All right.

Chairman GORDON. And there will be additional time. I talked to Governor Richardson yesterday. He would like to come also and—

Mr. ROHRABACHER. Good.

Chairman GORDON. So we wouldn't—there will be transparency, there will be balance, and that is what it is going to take to get a good bipartisan authorization. That is what we want to do.

Mr. ROHRABACHER. Thank you.

Chairman GORDON. I didn't say unanimous, but at least—I would like to see that, though.

#### VALUE OF RETURN TO MOON

Mr. ROHRABACHER. All right. Well, Mr. Chairman, thank you very much, and I will proceed now with my five minutes. It seems to me that what we have here are three major issues, and that—one is the viability of depending on commercial space companies versus government employees in providing access and transportation related to space. Another question is going back to the moon, whether or not that is worth the price that we will pay, and the funding of other space projects that will be de-funded because we no longer have the money for those space projects. And number three, what about the Constellation and the Ares rocket system? Was that system worth the price, and was that a right decision to move forward—or the administration's thinking about moving forward to cancel that. First of all, just one note. I certainly do not believe that keeping around a NASA workforce because it will disappear if a commercial company is given a contract is right thinking. I will have to suggest that people go to those private companies, and those private companies are developing workforces of their own. And I think that quite often the private sector has been able to do things in our history that government employees have not been able to do. I would—I will study up the history of NPOESS. I do not necessarily believe that all of the problems at NPOESS were caused by the private companies, namely Northrop Grumman. I cannot—I will go back and look at that to see if that was the genesis of the problems with NPOESS, instead of—versus changing demands and goals by the government bureaucracies that were overseeing and micromanaging the NPOESS project. So I will take a look and see if you have got a point there, Mr. Young. And you are more of an expert on this than I am, you have spent more time at it, but I would like to look at that particular assertion a little closer. And that especially is magnified when I realize that what we are talking about here is, you know, not relying on private companies and moving forward with spending billions of dollars on a crew rescue vehicle, but it seems to me billions of dollars for a crew rescue vehicle that will be in place just prior to the space station being retired, spending billions of dollars when we could cut that cost dramatically by—and using those dollars elsewhere, and contract with the Russians in the meantime. Isn't—there are billions of dollars that we don't have for our space program. So when we have those kinds of decisions being made, it gives me a little bit more faith in the private sector to be rational, and commercial companies, rather than just government employees who don't have to prioritize about spending. So let us get to the first issue, return-

ing to the moon in terms of—as a use of our—a better use of our space dollars. Mr. Cernan, let me ask you about that. Would not—and by the way, I am not opposed to going back to the moon. I think that we need to look at it and really study this to see if this is the wisest use of our money. But it will cost a lot of money for us to go back to the moon. Would it not be better, if we were aiming to deep space and Mars, to use that money developing, for example, a space refueling system that would permit us to refuel our rockets in space, and then go on to further exploration?

Captain CERNAN. Sir, when you go back far enough, when President Kennedy said, we are going to go to the moon, 50 years ago, he was asking us to do the impossible. He was asking us to do what couldn't be done. Now, going to Mars today is not necessarily impossible, but it is one gigantic leap for mankind, if I may use Neil's words, beyond going to the moon. And there are so many ramifications with—about going that far for that long that we have no hint about, and the—the moon is a natural satellite. It—is it thereby coincidence—it is there. It is a useful tool for us to demonstrate our capabilities to, you know, you can go into the scientific side of it, put up telescopes and so forth. We can demonstrate our capabilities to able to go deeper into space, plus we can go, you know, is there water on the moon, and where did it come from?

Mr. ROHRABACHER. Right.

Captain CERNAN. South Pole, Helium 3.

Mr. ROHRABACHER. And getting to the moon, now, does this require . . .

Ms. GIFFORDS. [Presiding] Mr. Rohrabacher, I just want to also—

Mr. ROHRABACHER. Yeah.

Ms. GIFFORDS. —just let you know that we—because we are running out of time, and all members—

Mr. ROHRABACHER. Right.

Ms. GIFFORDS. —haven't had a chance to speak yet, and I hate to cut you—

Mr. ROHRABACHER. Yes. And—no, you are absolutely correct. There are many questions we should have. Thank you so much, and I really admire our panel, all of our panel, including Mr. Young.

Ms. GIFFORDS. Mr. Young?

Mr. YOUNG. Yeah, if I could—if—after that, I have got to say something. No, in all comments—the comment that we are talking about commercial companies versus the government is, with all due respect, is kind of missing the whole point we are trying to make. It is not commercial versus government. It is commercial versus a team of government and commercial. Second item is I did chair the NPOESS review, and I would be delighted to come by and tell you more about what we found, if you would like to—

Mr. ROHRABACHER. Thank you.

#### WORKFORCE MORALE

Ms. GIFFORDS. Thank you. Gentlemen, again, welcome. We are very honored to have the three of you before our committee today. I believe that you saw the video of the pad abort demonstration flight that I played during the first panel. And, again, it was ex-

traordinarily successful, and a real test to the engineering—the capability of this country. All of you have decades of experience in very demanding aerospace undertakings, and I just—in continuity with the comments made by Mr. Rohrabacher, I would like to talk about the importance of program continuity and stability, since the three of you have tremendous experience in this area. What did it really take to make these successful flights possible? As you know, Congress has directed NASA to continue to work on Constellation. We heard that from Administrator Bolden himself this morning. Yet, at the same time, the workforce is being told that the—by the agency that Constellation is dead. So can you talk specifically, the three of you, about the morale and the motivation and what happens to the workforce when you hear those conflicting messages? And I would like to start with you, Mr. Armstrong.

Mr. ARMSTRONG. Thank you, Madam Chairman. My information in this subject is largely anecdotal. I have received e-mails from a variety of sources within NASA and different NASA centers talking about the problems that the uncertainty of current planning confirmation has engendered among the workforce there. And my sense from the number of such reports are universally on the side that morale has been degraded substantially, and indeed people are looking for jobs outside the NASA centers. I had the pleasure of talking with the recent shuttle crew this morning, and we asked them that question, and they seemed to think morale was reasonably good in the area. They—there are possibilities, from their perspective, in the months ahead where—that they could train to be on the space station, ISS, or they could go into some other managerial positions in NASA, or, if they were military, they could go back to the military. That probably is not the best choices they would like to have for their future, but I would yield to others who have maybe more definite information than I have available.

Ms. GIFFORDS. Thank you. Mr. Cernan?

Captain CERNAN. Well, I think they were being too kind if they said the morale is good. You know, you talk about the astronaut corps, and these guys are all—these are young men and young women. They are scientists, they are engineers. They are just not pilots. They are just not young men and women running around in blue suits. They get down and dirty with the—with Mr. Young's engineers out there, and helping design, develop, test 24/7 the spacecraft that they are eventually going to fly. And, you know, I asked a lady who works for NASA, who is an engineer, whose husband happens to be an astronaut. I said, you know, he just came back here a few months ago, and is he still on flight status? And she said, what flight status? You know, where does he go? Where does this young talent, the best of the best, where do they go and what do they do? So it is hard for me to—I put myself in their place, and, you know, I was sorted in a way after Apollo 17. We were going to wait five years for the shuttle to become operational. And I said—well, I was fortunate. I had flown three times. I had done my thing, and I wasn't sure I wanted to wait five years, so I went somewhere else. And you are going to find all those non-astronauts, all those engineers, all those technicians and support people, how can they not? I know Kennedy—the morale at Kennedy's not very good right now, and I can tell you Johnson is not much better.

They are out looking to get ahead of the job hunting game, because if this proposal goes forward, they are out of business. They are out—at least they are out of the kind of work they would want to be into.

Ms. GIFFORDS. Mr. Young?

Mr. YOUNG. I think the comments you have heard really are right on. I will take a little different perspective. I have had the privilege of leading some large organizations, both within NASA and within the industry. The fundamental challenge of somebody leading such a large organization is providing, one, stability, and two, an honest appraisal of the situation to a workforce. People—and, you know, mostly it has been associated with technology, space, national security activities. People don't look at that as a, you know, a five day a week, eight hour a day job. You know, it is remarkable what people will do, but they need to have an understanding. They need to have stability, and most of all they need to have challenging work, where what they do makes a difference. When you are in a job where what you do makes a difference, there is no limit as to what you apply. But if you are in a job where what you do might have no benefit tomorrow, such as a program being cancelled, or you might not have a job tomorrow, that is when the time around the water fountain becomes the dominant time. So I can't overemphasize how important—I think the video that you showed, you know, probably is a demonstration of that. Probably—I mentioned it earlier, but I didn't really come back, knowing a little bit about how that came to be, that was the best of NASA and best of industry working together to make what happened in there successful.

#### VIABILITY OF THE PRESIDENT'S PLAN

Ms. GIFFORDS. Just a quick follow up, just a yes or no answer from the three of you. I know that you have had a chance to testify in the Senate, and you have had a chance to hear our panel earlier asking questions to Administrator Bolden. At this point, do you believe that the President's plan as proposed is executable? Mr. Young?

Mr. YOUNG. No.

Ms. GIFFORDS. Mr. Cernan?

Captain CERNAN. Absolutely no, and—extremely—

Ms. GIFFORDS. Yeah. And Mr. Armstrong?

Mr. ARMSTRONG. If the question is would they be able to spend the money, my—

Ms. GIFFORDS. Your microphone, sir.

Mr. ARMSTRONG. If the question is would they be able to spend the money, the answer is yes. If the question is, could they receive value from it, I would say highly unlikely.

Ms. GIFFORDS. Thank you, gentlemen. Next up we are going to hear Mr. Olson, Ranking Member Olson.

#### IMPACT OF THE AUGUSTINE REPORT

Mr. OLSON. Thank you, Madam Chairwoman, and thank you Mr. Armstrong, Captain Cernan, Mr. Young, for coming here today, for giving us your expertise, and most importantly, for your service to

our great nation. Again, we thank you very much. My first question is for Mr. Armstrong. I know, Mr. Armstrong, you have been—had some concerns about how the Augustine report has been utilized by the administration, and for those who believe that the Augustine report is—as the basis for calling the Constellation program unexecutable, I kind of want to get your thoughts on that, because I don't believe it is, and I want to get your thoughts.

Mr. ARMSTRONG. Thank you. I remember hearing that unexecutable very early, and so I looked at—I couldn't find it in any of my dictionaries, so I just tried to guess what it might mean, and—it mean no execute. That could be it can't be performed, or it could mean it can't be killed. I don't know which—it seems to me, in studying the report—which—and I think the report was a very good one, considering the fact that they had a small number of members on the committee, admittedly assisted by NASA people and others, and a very short time to judge new programs, which were largely undefined, against the—what they called the program of record, I think. And that is—was developed over—as this committee knows well, over a long time period of money—many years, with hundreds or thousands of people looking at it. So it is a very difficult for—job for them. The second part, that they were obliged to look at the program of record as limited by the 2010 budget, which was substantially below the 2009 budget, and indeed significantly below the 2011 budget. My expectation is, had the ground rules been different, they—their findings would have been different. So—they had a built-in barrier toward making a—what I would call an equitable judgment. Having said that, I do think they did a credible job with the report, and it is well written.

#### MAINTAINING AMERICAN LEADERSHIP IN SPACE

Mr. OLSON. Thank you very much—my former boss, Phil Graham, might agree with you, with your deducting of non-executable as something you can't kill. He believed that the hardest thing to kill in the world is a government program once it gets enacted into law. So thank you for your answers. Captain Cernan, real simple for you. Given where we are, what would you do going forward to keep us on that path and maintain our leadership in human space flight and keep our exploration capabilities the greatest in the world?

Captain CERNAN. Well, very quickly, I think I alluded to that in answer to an earlier question. I would find out what the real capability of getting Ares—the real timeframe for getting Ares, Orion—full up Orion into Earth orbit is, and I am just making an assumption it is 2015. And I would fill that gap with the shuttle for all the reasons I mentioned earlier. The gap is going to be so significant to us if we don't close it, and we need to close it from both the front end and the back end. And the only thing on the front end is what we have got flying today, which is the shuttle. What we have got on the back end, that can do it as quickly or quicker than anything else, is Ares I, Orion. And during that period of time, as Ares I evolves into a heavy lift booster, we can then decide and make plans for space exploration to follow. Now, if that means we can do a fly-by to an asteroid or a fly-by of the moon, why, we are then moving forward step by step to develop Altair a lunar

landing capability, that is fine. But what I said earlier, we need to say from this point on is that is the destination. That is where we are going. Whether we get there in 2020, 2018, 2028, I don't care. And for all those kids out there, we—they need to know what their future has for store for them, in terms of, you know, let me just say this. Space and aviation has been a romance for over 100 years, and that is why we are here today, and that is why a lot of people perhaps are on this committee. And the legacy of the Wright Brothers is not the—we can higher, faster and further than anyone else has ever flown in the world before, but the legacy is the dreams that they inspired in the hearts of all of those who followed in their footsteps. And that is what I'm talking about when we need to provide a destination, a plan, a future for these young kids out there. My grandkids—I am selfish. I am concerned about them.

Mr. OLSON. Thank you very much, and I yield back the balance of my time. Thank you.

Ms. GIFFORDS. Ms. Kosmas.

#### INVESTING IN ENGINE DEVELOPMENT

Ms. KOSMAS. Thank you, Madam Chairman. Thank you all for being here. I represent the Kennedy Space Center, so obviously my concerns with regard to the workforce and the gap that you just described are great, but I would like to start by thanking you for what you all do. You exemplify and articulate, I think, the imagination, the inspiration, the innovation, the expertise, that we all want to maintain, and we want to ensure that America's future rests on that kind of inspiration. And so I thank you for your service, and also for being here today, and to describe to us your positions on these issues in a way that is very clear, and gives us a great deal of food for thought going forward. I had a couple of specific questions. Captain Cernan, first of all, your answer to the previous question was interesting to me, specifically because you talked about filling the gap with the shuttle, and I had a conversation earlier with Administrator Bolden about the feasibility of that. And while he accepted that the additional one flight was doable, he was not quite as clear on whether he thought additional flights to fill the gap could be done. Essentially he agreed that the shuttle is safe, that the re-certification has been done, and that it is safe, but logistics, as he called it, were the difficulty. I think we can work around that, perhaps, if it is decided that the shuttle would be the vehicle, since it is the vehicle we have now that would give us the access to the International Space Station for payloads, for spare parts, and also, obviously, for crew, and the only vehicle that we have at the moment that will do that. So I appreciate your suggestion there very much. I wanted to ask a question about—to all of you about the President's proposal, as it calls for a significant investment in technology, specifically for the development of a heavy lift vehicle. And I guess the question begins with this, are any of you aware of a substantial technology gap or technical issue that warrants our spending this large investment, or do we already have this technology available to us? And the—to compound that question, NASA's RFI for heavy lift launch system and propulsion technology states that affordability—this is a quote “affordability and load development and recurring costs are some of the guiding

principles.” And so I am asking what are the tradeoffs of investing in engine development to achieve lower costs versus saving time by using or modifying existing engines? That would be open to all of you. Mr. Armstrong?

Mr. ARMSTRONG. Thank you. We know an awful lot about rocket engines. I have flown on 13 different kinds. We know what the specific impulse is for almost any combination of propellants. We know what expansion ratios do. We know what material costs of case—and weights of material cases for liquid and solid rockets, and that doesn’t mean there won’t be advances, but—because there will, and what—with additional research. Nonetheless, we know pretty well right now how to build a big rocket, or a middle sized rocket, or a little rocket, and we know what the tradeoffs are for different component configurations that we can choose from. So while I think there are small increments to be gained by additional research in rocketry, my guess is that we can today build a pretty decent rocket in almost any size range that you designate. So I suspect that the decisions that were made as a result of the—choosing the Constellation program, which largely were based on schedule and affordability, would not be changed much by more research. We might find that certain other combinations have slight advantages and disadvantages, but I don’t think there would be any game changing kinds of decisions from that.

Ms. KOSMAS. Mr. Young, did you want to comment?

Mr. YOUNG. Yeah, I would.

Ms. KOSMAS. Thank you.

Mr. YOUNG. I think, first off, NASA does need a focused space technology program, so my comment doesn’t need to be—answer that. But the only prerequisite we need to get in—heavy enough launch vehicle is funding. I mean, we have the ability today to proceed with a heavy lift launch capability. We will probably develop some technology work as we go along in the implement of the program, but getting on with it is not being paced, in my view, by our ability to do it or our need for technology. It is only paced by funding.

Ms. KOSMAS. Could you answer the question as to what kind of funding it would take to accelerate that?

Mr. YOUNG. I don’t know that I can really answer your question. You know, what I would really like to say in response to that is that—that is why we have a NASA, and NASA has extraordinary capability to answer, you know, questions like that, if they are given the opportunity to do so. So I would, you know, I personally would be quite comfortable with NASA being given the assignment of what resources would it take to do a heavy lift, and how soon can we really get on with it?

Ms. KOSMAS. Okay. Thank you. I yield back.

Ms. GIFFORDS. Thank you, Ms. Kosmas. Mr. McCaul?

#### MORE ON MAINTAINING AMERICAN LEADERSHIP IN SPACE

Mr. MCCAUL. Thank you, Madam Chair. I want to thank the distinguished panel. Mr. Armstrong, I must say, it is a real honor to be in your presence here today. I think we were talking before, 1,000 years from now, no one in this room will be remembered, no one in this town will be remembered, except for you. And that is—

it is a great honor. On the wall behind me it says, "Where there is no vision, the people perish." President Kennedy, I think, had that vision, and it landed you on the moon. I am concerned that this President doesn't have that vision in his decision to cut the Constellation program. I was compelled by your testimony that the priorities are American leadership in space, access to space, and exploration, and I agree with you on that, and also your comments that you were astounded by the President's proposal and that it was painful to watch. And then, finally, in response to the question, can the President's plan be executed, we had a no, no, and a highly unlikely. That is very powerful. I mean, you are the experts. And the morale is another issue, but my question is, by cutting the Constellation program, what damage will that do to our superiority in space, to our national security? And the idea that we can somehow hand this off to commercial space flight, which maybe down the road could happen, my concern is that the handoff, it is not an appropriate handoff. They can't pick up the ball and run with it right now. And my concern is what is going to happen is we are going to have a gap in our superiority in space, and we are going to lose to the Chinese and the Russians. And so, with that, Mr. Armstrong, can you give me your thoughts on that?

Mr. ARMSTRONG. Thank you, sir. I certainly agree that if, for the next decade, we have no access to space, we will be viewed by people around the world as being has-been, and that—I would find that extremely uncomfortable with the enormous investment in resources and people's time over the past half century that we have expended in order to gain the position of leadership that we have enjoyed in recent years.

Mr. MCCAUL. Gentlemen, you—

Captain CERNAN. May I add something very quick to that? If we are viewed by other nations, other people around the world, as being willing to give—to abdicate our leadership in space, what else do they believe we are willing to dismantle without reason?

Mr. MCCAUL. That is very powerful, and I couldn't agree with you more. Mr. Young, do you have a response?

Mr. YOUNG. The only comment I would make is I think the reason all three of us advocate Ares I, Orion, the elements of Constellation, is that it is our view that, given where we are today, it is the best way to get an assured access to low Earth orbit. I mean, it is the fundamental underlying view for why we are advocates of that solution.

#### IMPACT ON NATIONAL SECURITY

Mr. MCCAUL. Captain Cernan, if I could just follow up? You had responded, what else would they be willing to give up? This—the backdrop to the space program has always been national security as well, and that is one of my main concerns with this decision by the President. Can you comment on that?

Captain CERNAN. I am sorry?

Mr. MCCAUL. In—what impact will this have on our national security?

Captain CERNAN. Oh, I think it will have significant effect. We won't have for some—well, you know, if the shuttle—if we give up on the shuttle today—the shuttle doesn't just service the space sta-

tion. It is an asset for national security. We can access any—probably almost anywhere in lower Earth orbit we need to be to do anything we want to do. Repair, recover, replace satellites. We can—scientific missions, like the Hubble. I think it affects our international security because we don't have access. We don't have the capability to be there when we need to be there. We are hostage—literally hostages, I say, to other nations. And it also implies, subjectively, that we no longer care. We no longer—we, you know, something happens in some other place in the world, don't worry about it, they don't care. They are not going to come to our rescue. They are not going to protect freedom around the world, which is something, I guess, for the last 200 and some odd years we have been destined to do. So there is—there are subjective reasons, as well as a physical capability to access a plateau that—it, you know, above the Earth, you know, to do things that could never have been done there before, from a national security point of view.

Ms. KOSMAS. Thank you, Mr. McCaul.

Mr. MCCAUL. Thank you, Madam Chair.

Ms. KOSMAS. Gentleman's time has expired.

Mr. MCCAUL. Thank you for your testimony.

Ms. KOSMAS. Mr. Grayson, you are recognized.

#### ASTRONAUT SAFETY CONCERNS

Mr. GRAYSON. Thank you. I want to thank you very much for the inspiration that you gave to me when I was younger. I want to thank you for inviting me to re-think what is capable for human beings to do. And I want to thank you both for what you have done not just for me, but for millions of people just like me. So, thank you. One of the pleasant parts of this job is the chance to meet people like you and to give you my thanks. I remember your mission. I remember your mission. I do remember a mission in between that didn't go as well, and I wanted to ask you a little bit about that. I told the NASA Administrator recently that my sense is that if a commercial enterprise, in running the space program at the time of Apollo 13, then all of those hundreds of engineers, mechanics and other astronauts who worked so hard to make sure the three men returned to Earth safely would have been replaced by one 20-year-old in a Grateful Dead t-shirt working on a laptop. I am concerned that replacing NASA at the head of the manned space program with some TBD commercial enterprise will, in fact, dramatically compromise the safety of the astronauts, and I would like you all to address that point, starting with Mr. Young.

Mr. YOUNG. The two gentlemen to my right are the most qualified to say that. I think it would go even well beyond that. I think it would jeopardize the safety of the United States human space flight program.

Mr. GRAYSON. Because one failure would have such dramatic repercussions?

Mr. YOUNG. Well, yeah, but, see, my definition of failure is—it could be a flight failure, or it could be just a massive overrun, or it could be just a massive schedule delay, which we have seen a few of, or it could be the failure to be able to complete a program, which we have also seen. So I think failure can be any of those, you know, of those circumstances. And so either one of those, I

think, would have just a devastating impact on not only NASA, but the United States human space—United States space program.

Mr. GRAYSON. Captain Cernan?

Captain CERNAN. Many years ago I worked on Apollo—we learned about the Russian program we never knew, and sometimes it is as important to know what they didn't know as much as what we didn't know. And the Russian cosmonauts would play volleyball and swim and had requirements to stay physically in shape and do a little homework on the physics and geometry of the world, and they would send them down to Baikonur and open up a hatch and put them in and off they would go. I said earlier, and I don't want to spend too much—we lived, 24/7, from the day we got involved with our spacecraft, whether it was Gemini program, Apollo or whatever it is, we lived, we owned, we knew the people who were building it. They dedicated their lives to putting the screws in the heat shield so that it wouldn't come apart when we re-entered the Earth. This is the kind of culture we grew up and we lived in. Now, if it went to the commercial sector, as an astronaut, I have got to believe we would have to—we would have to recreate that culture, or I am not getting in it. I mean, I didn't go to the moon not to come home. I mean, I planned to come home all along, but I knew I was coming home, because of those people, and because of the culture that we worked within at NASA.

Mr. GRAYSON. And last, but for sure not least, Mr. Armstrong.

Mr. ARMSTRONG. I included in my written testimony some comments regarding commercial—first, I say I am very much in favor of the commercial activity and their—and I am very hopeful that they will have the progress that they hoped for. Nevertheless, they face a very difficult business case. It is—the market is extremely thin, and they—the investor contribution to that project is going to be—must be substantially larger than the government contribution, by their business plan, and that business plan looks highly suspect. I recall recently reading an article by Brewster Shaw, former astronaut and now working a responsible position in space for Boeing, and he was trying to explain to the readers the difficulty he faced in convincing his boss to—that that was a good business to get—there is a good enough chance for that to be a business success that they should get in it. He said, it will be a hard sell, but, he said, I am hopeful. And it is going to be equally difficult for any other commercial space provider to make that case to their investors without the developed market. And I think that is a serious impediment that they just—we need to recognize, and they need to overcome. And I hope they can, and I hope that market develops, but right now it is very difficult to see that it will.

Mr. GRAYSON. Thank you.

Ms. KOSMAS. Thank you.

Mr. GRAYSON. Pleasure and an honor—

Mr. YOUNG. Could I just—

Mr. GRAYSON. —meet you all.

Mr. YOUNG. Could I just add briefly to that?

Ms. KOSMAS. Okay. Yes.

Mr. YOUNG. Neil's comments and Gene's reminded me of this, but the, you know, there are extra steps that make these things successful. When Apollo was being developed, I was actually at

NASA's Langley Research Center, and I was working on a program called Viking, where we land a couple spacecraft on Mars. Langley actually built something that looked like a big saw bench that a 1/6 G simulator. You could fly—flights at 1/6 G, equivalent to the moon. And I used to drive home late at night and ride by when the lights went on, and Neil Armstrong was in there flying that test vehicle, practicing for going to the moon. They are kind of—they are the extra things that make these things happen, Langley building that facility, you know, Neil coming up from JSC to fly it, the industry people being evolved. You know, it is just an example, but you reminded me of it. That is the kind of partnership that makes these things happen. You don't write that in a safety requirements document. You probably would never write in there, if you are not doing anything on Friday night, why don't you come up and fly the 1/6 G simulator? So they are the—it is no special ingredients. That is why this business, which is a one strike and you are out business, has been as successful as it has been. Thank you.

Ms. KOSMAS. Thank you very much. Mr. Griffith, recognized for five minutes.

#### TECHNICAL SHARE OF THE CONSTELLATION PROGRAM

Mr. GRIFFITH. Thank you, Madam Chair. I appreciate you all being here. I am from Marshall Space Flight, Huntsville, Alabama, retired physician who take care of many of the pioneers there, and I can say that, without a doubt, even in their most ill moments, their culture, manned space flight culture, always came through. And I think the culture, and seeing the Saturn, seeing and talking to people who hand soldered and who put it together and who gave their lives for it, when I hear someone say that these individuals can find a job somewhere else, this was never a job. This was a calling, and so we see that over and over again, those of us who were involved in communities with the space flight. The thing that I am concerned about, as the discussions are framed, is—I keep hearing budget, and I don't think we are talking about money here. I think we are talking about commitment. I think if America can do a \$787 billion stimulus, bail out AIG, and other things that we have done in the last 18 months, and we can't find \$12 billion to finish Ares I, our heavy lift vehicle, Ares V, which will eventually be the very soul of America to the rest of the world, is a lack of commitment, and it is alluring of the President's suggestion on April the 15th that we were not in competition globally for space and exploration and science, I think was a misstatement, either through naivete, or he is ill informed. We are, in fact, in a competition. And when I hear Mr. Augustine say over and over again all Ares—all the Constellation project needs is money, I believe he is right. And I don't think it is a budgetary concept. I think it is a commitment concept that we have not made, that we need to make, and I think that is why the Obama administration is running into a stone wall here. So I have listened to the comments, and I think my only question to you is do you agree with Mr. Augustine, that our technology is there, that our Ares I, our Ares V solutions are sound, and that, if we were—had committed the proper funding to it, we would not be having this discussion?

Mr. ARMSTRONG. I believe that to be true, sir.

Mr. GRIFFITH. Thank you.

Captain CERNAN. Yeah, I don't think there is a flaw in the program, except lack of funding.

Mr. GRIFFITH. Thank you.

Mr. YOUNG. There is no one I respect more than Norm Augustine, and I agree with that. There is also data that provides additional support and information, and for Ares I and for Orion we have completed preliminary design reviews, you know, that—the assessments that I have read, and have heard people actually testifying about, is, from a technical standpoint, this program has proceeded in a very successful manner. So I think that—I have not heard anyone who has said there is any issue with Ares I, Orion, other than insufficient funding to meet schedules.

Mr. GRIFFITH. Thanks. My other question would be that—it would appear to me that, with the successful completion of the Constellation project, that our ability to commercialize space would be—would have much more potential. It would be much safer, it would be much quicker, than the way—the suggestions are that we are going to put something out for competitive bids. We put out the tanker project for—in 2001. We don't have a tanker yet. We are not refueling anything. We put space out, which is a national security issue, for competitive bids, we are basically saying to China and Russia, we are walking off the court, the game is yours. And so I concur in that, and I appreciate so much you all being here. The soul of my district is—are the rocket scientists, so thank you so much.

Mr. YOUNG. If I might comment, we actually have an endeavor to pursue the commercialization of space, and that is commercial cargo, as you are well aware. And while I think commercial cargo is not without risk, it is an opportunity to grow and to demonstrate a capability. And on the other hand, if the unfortunate happens and it is not successful, in my view, it fails soft. There is other ways to do it. Commercial crew fails hard, and that is the fundamental difference. I guess the other comment I would make also is—and maybe I am not the right person to do this, but having spent a little bit of time in industry, we should not set up this commercial endeavor to fail. Don't make the bar so high. You know, have a responsible bar that can be achieved, and if achieved, then there is an opportunity to raise the bar. But don't try on the first jump, you know, to set a world's record.

Mr. GRIFFITH. Thanks.

Ms. KOSMAS. Thank you very much. Thank you, Mr. Griffith. Before we bring the hearing to a close, I want—

Ms. WOOLSEY. Wait a minute.

Ms. KOSMAS. I am sorry.

Ms. WOOLSEY. I asked to be on the—back on the list quite a while ago.

Ms. KOSMAS. Oh, I beg your pardon. I am sorry. The Chair—

Ms. WOOLSEY. Okay.

Ms. KOSMAS. The Chair recognizes Representative Woolsey.

Ms. WOOLSEY. Thank you. I stepped out of—I was the second person, and I thought, no, I am just going to listen. But, you know, your testimony brought up so many memories, and I am the perfect clean-up batter, besides our Chairwoman here. Commander Arm-

strong, my kids were, all four of them, four, six, seven and eight when you took that step on the moon, and we sat there spellbound, our entire family. It is a day that I can still remember the colors of their t-shirts. I mean, that—it is one of those days. I remember that one of my sons had a loose tooth. I mean, we don't forget that. And my career was wrapped totally around the technology that came from the space movement. I was part of a startup telecom company. So it was very clear to me that—and we all knew that that company would not have been able to spin off from Bell Labs without the science from the space industry. So I have been questioning, while we have been sitting here, why I—and my—well, there aren't enough of us here to—but my colleagues will tell you, I have been very nonplussed about the space program, and I am on this committee, and blah, blah, blah. That is because I see so many needs in this country and in this world that I—but there is another because. I never ever thought the space industry would not be vital in our country. I took it for granted, and I had to go do other things that I thought were important also, until it became clear to me that our leadership is willing to let other nations send—transport our astronauts out—into space. And all of my competitive juices just got going. It was, like, no way. We are not going to pay another country and depend on them to take care of what we need in the United States of America. So you have reminded me today of exactly how important the space industry has been, because you have been so important in the past. You are important today, and you will be important in our future. So your stories, your message, has to get out there. We will help you. You will help us. You really will. This has been a very important day, and when it woke me up, I realized we have got a lot of people in this country that think our space industry is there, it is solid, it will be there forever, we don't have to worry about it. So now we have got to remind people that we have got decisions to make, and we want to make the right ones. Thank you very much.

Ms. KOSMAS. Thank you, Ms. Woolsey. Before we bring the hearing to a close now, I want to thank our witnesses. I think you have been properly thanked by many of the members, but I personally would like to thank you as well for testifying before the committee today. And, for the record, the record will remain open for two weeks for additional statements from the members and for answers to any follow-up questions the committee may ask of the witnesses. So the witnesses are now excused, and the hearing is now adjourned. Thank you very much.

[Whereupon, at 1:55 p.m., the Committee was adjourned.]